

INDEXED

International Marine Engineering

JUNE, 1910.

BULK-OIL STEAMSHIP J. A. CHANSLOR.

There has just been completed at the yards of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., for the Associated Oil Company, of San Francisco, Cal., the large bulk-oil carrying steamship *J. A. Chanslor*. The *Chanslor* is the second large oil carrier built by the Newport News Company for the Associated Oil Company for service on the Pacific Coast, the other being the *W. S. Porter*, a vessel of about the same capacity, built in 1906. Both the vessel and her machinery have been built to class 100-A-1 Lloyds, under special survey, and in construction, equipment and outfit represent

by an oil-tight centerline bulkhead, thus making twelve separate oil-carrying compartments. In addition, on each side of the vessel, in the wing space outboard of the expansion trunk, there is one compartment arranged for carrying oil in summer. There are also settling tanks built into the hull on each side of the boiler room. The pump room is located between the oil tanks and the boiler room, and is separated from the former by a cofferdam two frame spaces in width. A dwarf cofferdam is fitted at the forward end of the oil tanks. There is a double bottom forward between the forepeak and the oil



FIG. 1.—VIEW ON THE MAIN DECK OF THE J. A. CHANSLOR.

the highest type of bulk-oil carrier. The principal dimensions are as follows:

Length over all.....	400 feet 6 inches.
Length on waterline.....	384 feet 2 inches.
Beam, molded	52 feet.
Depth, molded	30 feet.

On 23 feet draft the vessel has a deadweight carrying capacity of about 6,600 tons.

The general arrangement of the vessel is well illustrated on the accompanying deck plans and her general appearance by the accompanying photographs. From them it will be seen that in common with the majority of bulk-oil carriers the machinery is located at the stern of the vessel, and the body of the vessel is given over to the oil tanks. Of the latter there are five-cargo tanks, each sixteen frame spaces in length, and one fuel-oil tank 10 frame spaces long, all of the tanks being sub-divided

tanks, and one is also fitted aft of the after cofferdam under the pump room and machinery spaces. The forepeak tank and double bottom forward are arranged to carry either fresh water or water ballast; the afterpeak and the double bottom aft are arranged to carry fresh water. The space between the collision bulkhead and the forward oil compartment is arranged for carrying general cargo, there being complete lower and main decks in this space, the whole being fitted with cargo battens and close ceiling fitted on the tank top. Cargo space is also provided in the 'tween deck space outboard of the expansion trunk forward and aft of the summer tanks.

The vessel has a raised forecastle, open bridge and an enclosed poop. It is schooner rigged with three pole masts, each mast having cargo booms attached and fitted with stay-sails and trysails. There are three booms on the foremast, two on the mainmast and one on the mizzen, the boom on the latter being used for handling engine-room weights.

The construction of the vessel in way of the oil tanks is in general what may be called standard for bulk-oil carriers of the larger type. The side frames are channels extending from the keel to the main deck, where they are cut and angle-frames fitted between the main and upper decks. Web frames 20 inches wide are spaced four frame spaces apart, and there are three side stringers and two keelsons on each side of the centerline. All beams are channel section. An unusually large expansion trunk is fitted for the full length of the oil tanks. It is 24 feet wide, and extends from the main deck to 3 feet 9 inches above the upper deck, the effect of this being to materially increase the range of stability. The raised trunk has been very advantageously used for the running of the oil discharge piping on top of the trunk, and all conduit, etc., has been run along its sides. The piping on top of the trunk is all protected by galvanized ribbed plates, these plates also forming

room being finished in paneled quartered oak. Quarters for the other engineers and for the other members of the crew are located under the poop deck, those for the engineers being finished in oak, the bulkheads in all cases being of steel. A bath room for the engineers is provided. There is a mess room for the engineers and officers, and a separate mess room for the crew. The galley is located at the forward end of the poop and has a steel skylight over. Steel skylights, with hinged shutters, are also fitted at the sides of the engine and boiler casings on the poop deck to light the passages below. An idea of the whole general high-class character of the vessel may be obtained from the fact that the whole of the poop deck is laid with a calked deck of teak.

DECK MACHINERY.

A refrigerating plant for the ship's provisions is provided,

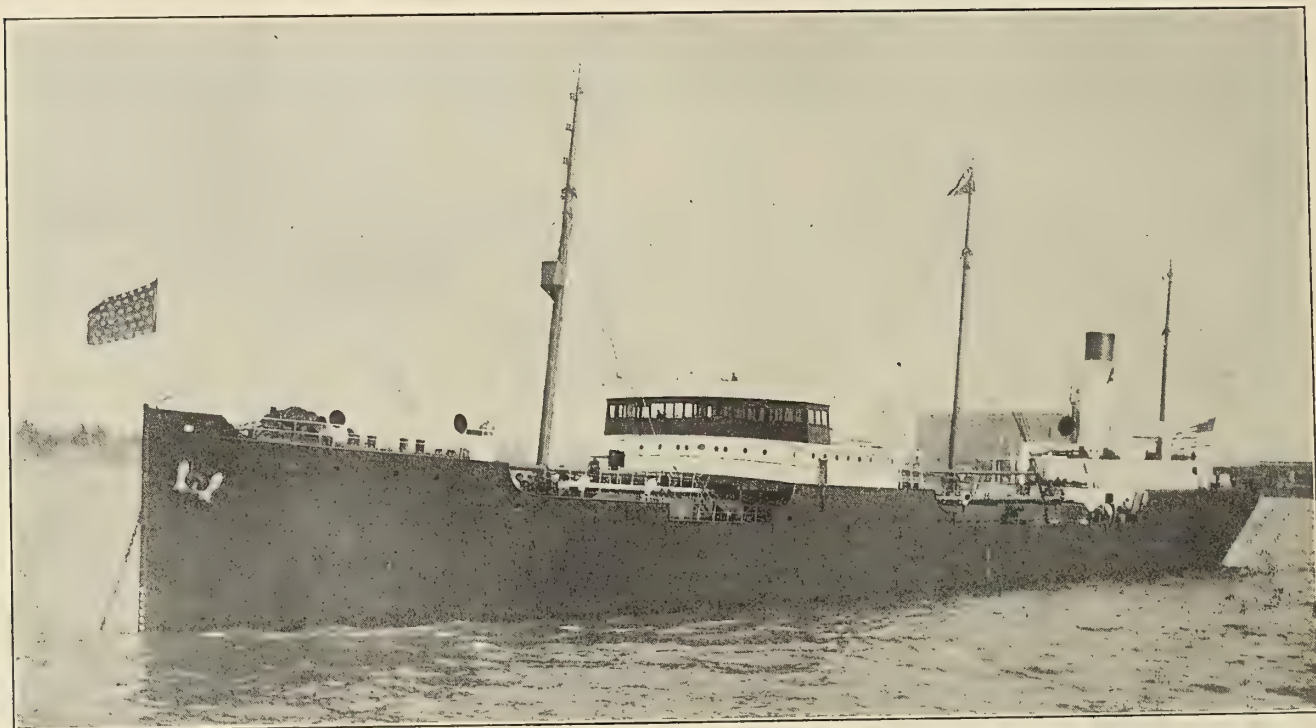


FIG. 2.—NEW BULK OIL-CARRYING STEAMER BUILT AT NEWPORT NEWS FOR THE ASSOCIATED OIL COMPANY OF SAN FRANCISCO.

runways from the bridge forward and between the bridge and poop, thus obviating the necessity for fitting a flying bridge.

Accommodations for the officers and crew are very complete. Amidships, in a steel house on the bridge deck, are located the dining saloon with attached pantry, the captain's stateroom, office and private bath, a spare room, staterooms for deck officers, also an officers' bath and two separate toilets. On the upper bridge deck is a teak house containing separate wheel room and chart room, access to which is obtained by enclosed stairs from the passages in the bridge house.

The dining saloon, captain's quarters and spare room are paneled in mahogany; the wheel house and chart room in teak, and the other quarters are finished in oak. Leather upholstered seats are provided in the majority of the rooms; folding lavatories in the captain's and spare rooms, and a brass bed in the latter. In the pantry there is a steam table and a coffee urn, in addition to other customary outfit.

The forward end of the upper bridge deck is enclosed to form a navigating bridge, the front and ends being fitted with sash, thus forming a very efficient wind shield, as is well illustrated in Fig. 2. A flying bridge is also fitted at the level of the top of the wheel house.

A stateroom for the chief engineer and a wireless room are located in a steel house on the poop deck; the chief engineer's

the cold-storage rooms being located on the main deck aft of the engine room, and a 2-ton ammonia compression machine, supplied by the Vulcan Iron Works, of San Francisco, Cal., is provided for circulating the brine through coils in the rooms. There is a very elaborate electric plant provided, consisting of three generating sets of 5, 7½ and 10 kilowatts capacity, respectively. These are all direct-connected sets of the General Electric Company's make and are located in a separate room abreast the engine casing on the main deck. A 14-inch searchlight is located on the flying bridge.

The steam-steering gear is of the Hyde screw-gear type, having an engine with 8-inch by 8-inch double cylinders controlled by hydraulic telemotor from the wheel house, the flying bridge and also at the engine itself. Auxiliary hand gear is also fitted with steering wheels located above the poop deck. In addition there is an emergency gear by means of which the vessel may be steered through the medium of the after steam capstans, the shafts of which are extended through to the upper deck and provided with drums for this purpose.

There is a Hyde steam windlass for handling the Baldt stockless anchors, the windlass being located on the forecastle deck and the engine on the deck below. The latter also drives a steam capstan which is located on the forecastle deck. On the poop deck there are fitted two Hyde warping capstans, which

are operated by a double 8-inch by 8-inch engine. There are also fitted two Hyde compound geared 8-inch by 10-inch winches, which are used for warping purposes. It will be seen from this that there are abundant facilities for warping and mooring the vessel, a special feature having been made of this point and an unusual number of large, heavy bitts and chocks provided. These were necessary to suit the exigencies of the trade in which the vessel will be employed, there being strong wind and tide conditions to contend with.

boats, bituminous covering on all exposed steel decks, and an engineers' workshop. The latter has a 20-inch by 14-inch lathe, a 22½-inch drill press and a No. 2 Northampton double emery grinder, all the tools being driven from line shafting, the power for driving being derived from a 7½-inch horsepower electric motor supplied by the Richmond Electric Company.

PUMPING SYSTEM.

The pumping system of an oil ship is necessarily a very im-

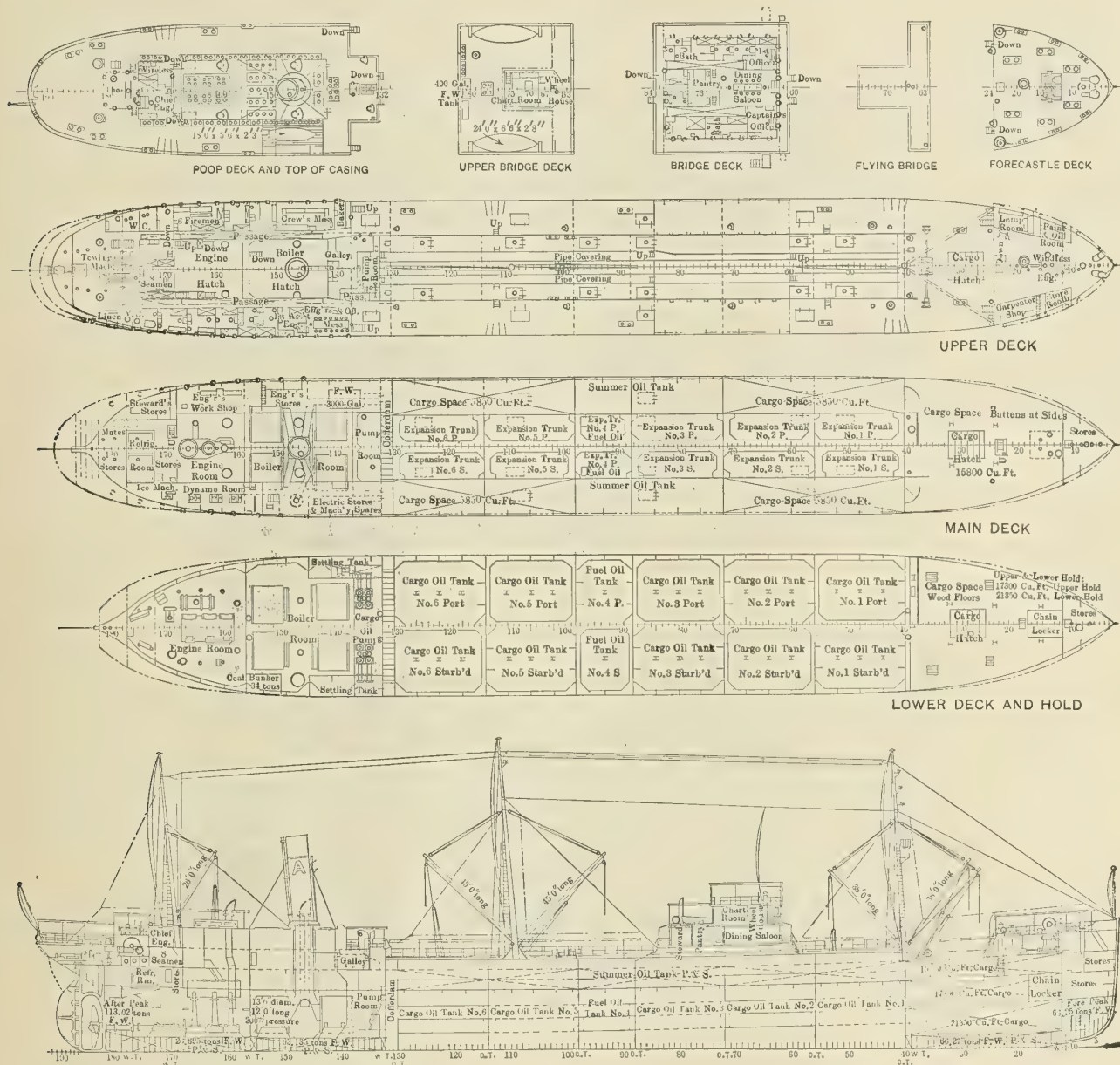


FIG. 3.—DECK PLANS OF THE J. A. CHANSLOR.

There is also a Providence towing machine of the Shaw-Spiegle type, 16 inches by 16 inches, for handling 1,800 feet of 2-inch diameter towing hawser. The winches, windlass, capstans and steering gear were all furnished by the Hyde Windlass Company, and the towing machine by Williamson Brothers Company.

Among special features not generally fitted on cargo steamers, but which are fitted on the *Chanslor*, are wireless telegraphy, installed by the United Wireless Company, a Nicholson ship log, telephone system between pilot house and engine room, Welin quadrant davits for handling the life

portant feature. That of the *Chanslor* is very elaborate. For the cargo oil system there are two Dow horizontal, duplex outside-packed plunger pumps, 16 inches by 14 inches by 18 inches, and for the ballast system one similar pump, 12 inches by 10 inches by 12 inches. The cargo oil suction system consists of a 12-inch main on each side of the vessel, with 10-inch branches to each cargo tank and 6-inch branches to each settling tank. A separate 6-inch suction is fitted to each fuel oil tank, and a 6-inch equalizing valve is also fitted in the center-line bulkhead between each pair of oil tanks. Each cargo pump is arranged to discharge separately or in combination into an

8-inch discharge belt main, which runs along the top of the expansion trunk, the two lines being connected at the forward end with a valve between. This main discharge extends on both sides to the after end of the poop and has 8-inch branches at three different points for connection to the discharge hose. Six-inch branches are also taken out of the main for discharging back into each tank. The discharge is so arranged that either pump can discharge into one side of the main or the other, and division valves are fitted so that one pump can work at a heavier pressure than the other.

The discharge system is so arranged that it may be used as a suction of either or both pumps. By-pass arrangements

the sea also, and to discharge overboard, to all oil tanks on deck or to the fire main.

On the lower deck forward of the oil tanks is located a Dow horizontal duplex, piston type pump, $5\frac{1}{4}$ inches by $4\frac{3}{4}$ inches by 5 inches, with suctions from the sea, the fore peak, the forward double bottoms and forward hold, and discharging overboard and into the fire main.

The after cofferdam is arranged for flooding from the sea, and it, together with the pump room, bilges in fire and engine rooms, after peak, and after double bottom tanks, are drained through a manifold in the engine-room to which the donkey pump and the engine bilge pump are connected.

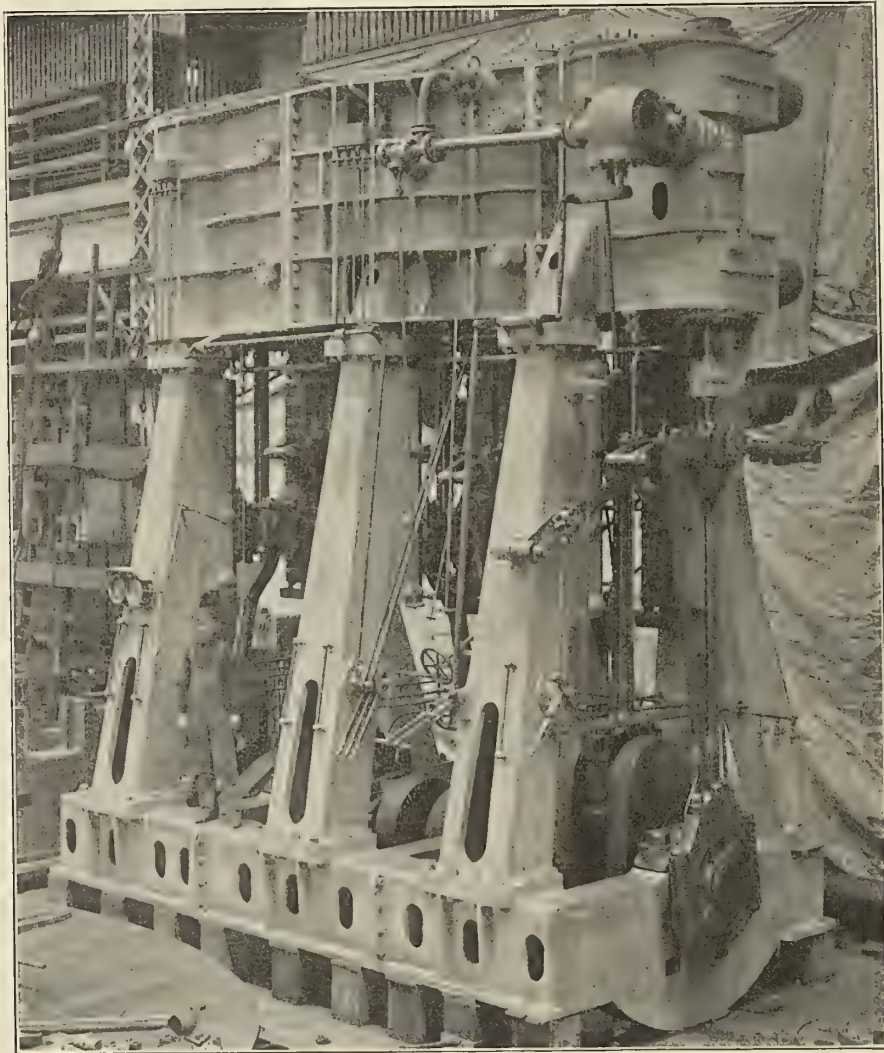


FIG. 4.—THE CHANSLOR IS PROPELLED BY ONE THREE-CYLINDER, TRIPLE-EXPANSION ENGINE.

are provided so that any tank on one side of the ship can be emptied and discharged into any tank on the opposite side, overboard, or through the suction system. All oil piping is standard black-wrought steel pipe with cast iron screwed flanges, and the valves are Crane cast iron gate valves. The suction system was tested to 125 pounds pressure, and the discharge system to 250 pounds pressure. Each oil tank is fitted with a $2\frac{1}{2}$ -inch air pipe lead into the masts.

A No. 3 Monogram Sturtevant electric exhauster is provided for drawing the gases from the oil tanks through the suction system and for ventilating the pump room. The motor for this fan is located in a special motor room, the fan being located on an extension shaft above the pump room.

There is a separate water ballast system with 8 inches suction to each tank, the ballast pump being arranged to draw from

PROPELLING MACHINERY.

As before stated, the propelling machinery is located in the stern of the vessel. It consists of one three-cylinder, triple-expansion engine, four main boilers of the Scotch type, and one vertical donkey boiler. The cylinders are $24\frac{1}{2}$ inches, 40 inches and 68 inches diameter, respectively, with a common stroke of 48 inches, and are arranged in the usual order with the high pressure forward. A separate liner is fitted in the high-pressure cylinder. Piston valves are fitted on the high-pressure and medium-pressure cylinders and a double-ported slide valve on the low-pressure, the medium-pressure and low-pressure valves having balance cylinders. All valves are worked by Stephenson double-bar link motion. Steam reversing gear of the direct-acting type with a steam cylinder, 14 inches by 20 inches, is fitted on the back of the engine. All

pistons are cast iron of box section, fitted with bull and snap rings. Tucker's metallic packing is fitted to all piston rods and valve stems. An Aspinall governor is fitted to the main engines.

The piston rods are steel, secured to the pistons and cross-heads in the usual manner, with taper end and nuts. The cross-heads are of forged steel, with double cast iron slippers, having white metal wearing surface. The connecting rods are forged steel, 9 feet between centers, forked at the upper end to suit the cross-head, with gudgeon and crank pin boxes of cast steel lined with white metal.

The crankshaft is 14 $\frac{3}{8}$ inches diameter, built up with steel shafts and pins and cast steel webs, and is made in two sections. The sequence of cranks is high-pressure, medium-pressure and low-pressure.

The bedplate is cast iron of box section, made in three sections with six main bearings. The main bearings are cast steel, lined with white metal, the bottom half being provided with water circulation. The housings are cast iron of box section, those in the rear being of the inverted Y-type. Separate cross-head guides, with water circulation, are fitted on both front and back housings. A steam turning engine, with single 8-inch by 6-inch cylinder, is fitted on the after port housing.

The thrust bearing is of the horseshoe type, having bearings at each end and fitted with 12 cast iron shoes provided with water circulation. The thrust shaft is 14 $\frac{3}{8}$ inches diameter, and the propeller shaft is 14 $\frac{7}{8}$ inches diameter, fitted with a composition sleeve the full length of the stern tube. Long composition bearings, lined with lignum vitæ, are fitted at each end of the stern tube.

The propeller is a four-bladed sectional one, with cast iron hub and manganese bronze blades. It is 17 feet diameter, with 17 feet pitch, and a developed blade area of 103 square feet.

AUXILIARY MACHINERY.

The condenser and all auxiliaries are independent of the main engine. The condenser has a cast iron cylindrical shell, with composition tube plates and $\frac{3}{4}$ -inch Admiralty metal tubes, which give a cooling surface of 3,594 square feet. Water is circulated through the condenser by means of a centrifugal pump of the Newport News Shipbuilding & Dry Dock Company's own make. It has a cast iron shell and composition runner, has 12-inch suction and discharge and is driven by a 8-inch by 10-inch single cylinder vertical slide valve engine. The main air pump is a vertical twin beam, single-acting Blake & Knowles pump, 9 inches by 20 inches by 12 inches. For port use there is also an auxiliary air pump, 7 $\frac{1}{2}$ inches by 14 inches by 10 inches, of the Simplex, double-acting, featherweight type, supplied by the Blake & Knowles Steam Pump Works. All other steam pumps were supplied by the George E. Dow Pumping Engine Company, of San Francisco, the engine-room pumps comprising the following:

Two main-feed pumps, horizontal, duplex, outside-packed plunger type, 10 inches by 6 inches by 10 inches.

One donkey boiler feed, horizontal, duplex, outside-packed plunger type, 7 $\frac{1}{2}$ inches by 3 $\frac{1}{2}$ inches by 6 inches.

One fire and bilge pump, horizontal, duplex, piston type, 10 inches by 6 inches by 10 inches.

One engine bilge pump, horizontal, duplex, piston type, 6 inches by 5 inches by 6 inches.

One fresh-water pump, horizontal, duplex, piston type, 6 inches by 4 inches by 6 inches.

One sanitary pump, horizontal, duplex, piston type, 6 inches by 4 inches by 6 inches.

Two evaporator feed pumps, horizontal, duplex, piston type, 4 $\frac{1}{4}$ inches by 2 $\frac{3}{4}$ inches by 4 inches.

Other engine-room features consist of a Reilly multi-coil feed heater of the closed type, and a Railton-Campbell grease extractor. There is also an evaporating and distilling plant, consisting of one 20-ton and one 12-ton Reilly evaporators and a 2,000-gallon distiller.

The boiler plant is of very liberal proportions, there being four main boilers, each 13 feet 6 inches diameter by 12 feet long, built for a working steam pressure of 200 pounds. Each boiler has three 41-inch Morison corrugated furnaces, with separate combustion chambers, and has 263 3-inch tubes, giving a total heating surface of 8,320 square feet. Each main boiler has a steam drum 36 inches diameter by 6 feet long.

The donkey boiler is a vertical one, 5 feet in diameter by 10 feet high, with a submerged head. It has 169 2-inch tubes, 435 square feet of heating surface, 14.25 square feet of grate surface, and was designed for a working steam pressure of 160 pounds.

The boiler plant is arranged for using fuel oil with steam atomization. Each furnace is fitted with a Staples & Pfeiffer automatic, superheating, self-cleaning oil gas burner, the oil being supplied by two 6-inch by 4-inch by 6-inch Dow horizontal duplex pumps, which discharge through special fuel oil heaters. Steam coils are also fitted for heating the oil in the settling tanks.

In the building of the *Chanslor* a good record for this type of vessel was made, it having been finished in ten months from the awarding of the contract. The contract was awarded June 20, 1909, the first keel plate laid August 3, the vessel launched February 12, the trial trip made March 16, and the vessel sailed for San Francisco on March 24, having previously taken on sufficient oil fuel, water and stores to take her to San Francisco without stopping at any intermediate port.

On her trial trip, in ballast condition, the vessel averaged slightly over 12 $\frac{1}{2}$ knots on a measured mile course, the machinery indicating 3,000 indicated horsepower. The speed in service will be about 11 knots.

One of the latest additions to the German Imperial navy is a 30-knot, 650-ton destroyer, equipped with Zoelly turbines. There are two main turbines, developing 7,500 horsepower each at 650 revolutions per minute. Although designed for a speed of 30 knots, the maximum speed attained was 33 $\frac{1}{3}$ knots, while the average for a three hours' full speed trial was nearly 32 knots. The data from the trial trip are reported to be as follows: Steam pressure at the turbine, 14.85 atmospheres; vacuum, 89.95 percent; revolutions per minute, 643.9; slip, 23.4 percent; average speed, 30.757 knots; steam consumption, 14.2 pounds. The exhaust from the auxiliaries was not passed into the low-pressure stages of the turbines. Had this been done the foregoing results, in comparison with figures from other official trials, would have been considerably modified.

The destroyer has a length of about 350 feet, and it is reported that the turbines ran smoothly during all the trials, both in the workshop and since being fitted in the destroyer.

The Bureau of Navigation reports that ninety-two sail and steam vessels of 29,125 gross tons were built in the United States and officially numbered during the month of April, 1910. Six steel steamships, aggregating 12,314 gross tons, were built on the Atlantic and Gulf coasts, and three steel steamships, aggregating 12,839 gross tons, were built on the Great Lakes.

The Marine Engineers' Beneficial Association No. 33, of New York, held its fifteenth annual banquet on the evening of May 5. It was by far the most successful meeting that the organization has ever held, not only in numbers but in good fellowship.

FUEL OIL.—III.

BY E. N. PERCY.

There are five broad systems of burning fuel oil and residuum. First, atomizing the oil by means of steam or air. This is done with low-pressure air at 8 or 10 ounces pressure, second, by high-pressure air or steam at 20 to 150 pounds. Second, atomizing by oil pressure alone; there being several systems in the experimental stage. Some depend upon the centrifugal action of a special sprayer, some the impact of one jet on another, and others by the impact of the jet on a specially prepared and shaped surface. Irrespective of their merits, these systems have never come into general use, and, so far as observed, tend to carbonize heavily unless all conditions are just right and very delicate adjustments made. Third, spraying with mechanical atomization. Formerly this was used with great success, but it has been completely supplanted by blast atomization. Fourth, by heating oil in red or white hot retorts or pipes, or in a coke fire, with or without steam; thus really making a gas. This process is absolutely impractical for marine purposes, but has a wide and growing field elsewhere. Fifth, by burning in shallow trough-like grate bars. This method is used a great deal in Russia for boilers, also in steel works in this country; but it is only successful with oils of a certain gravity, heavy enough to be safe and light enough to burn in this way; but it is obviously impractical for a ship in a heavy seaway.

For practical marine work we are limited to the atomization method by air or steam. If low-pressure air be used, engine-driven blowers must be installed. If high-pressure air, engine-driven compressors are needed. If steam be used, evaporators, must be provided to make up at least 1.5 percent of the total steam made in addition to ordinary losses; this representing the steam used by an average oil fire. Steam gives a longer, cooler flame, that burns with the same efficiency as air, and is not so hard on the brickwork and boiler but, obviously, takes too much water for a ship making long voyages. The marine boiler, therefore, is practically confined to the air atomizing system of using oil fuel, of either the high-pressure or low-pressure type, and we will consider these only, as steam burners do not differ materially.

Before taking up the burners in detail some of the main principles will be reviewed as established by actual practice. In the first place, it makes very little difference what burner is used, provided a fair atomization is obtained; much more depending upon the arrangement and experience of installers. (See report of naval board upon oil fuel.) In the second place, the most important thing is to obtain perfect mixing of sprayed oil and draft. In the third place, while almost any burner will work, as stated, under conditions of heavy fire, hot furnace and constant duty, there are many other conditions to meet in which the type of burner plays a very important part. Burners of any kind are divided into two great classes—inside mixing and outside mixing. The former mix the air and oil inside into a sort of lather, which is ejected in a more or less fine spray; the latter eject the oil and air separately, and they meet outside, and the oil is atomized by the impact and expansion of the air jet. There is very little choice; it is probable that most inside mixing burners can be adjusted to a smaller flame, more easily suspended in a cold furnace; while it is probable that the outside mixing burners will carry the largest fires and clog the least, and are the best for heavy service. The writer, personally, recommends one of each in each furnace, thus making it possible to meet all conditions, as no heavy-duty burner, so far as known, will work well with a very small flame; for instance, to keep the bricks hot when standing by.

The ordinary outside mixing burner does not differ ma-

terially from an ordinary perfume atomizer. It will be anywhere from 6 inches to 2 feet long, and may be exactly like an atomizer or it may have a central adjusting needle or cleaning wire, or the whole central piece may be removable for cleaning. It may be rifled at the point to make a rotary flame, or have a slotted point to make a flat flame. Some burners are both inside and outside mixing. Some are very elaborate, with adjusting needles, removable centers, contrivances to change the shape of the flame, etc.; but the tendency now is to simplify burners in favor of the central control system. Some people go to the opposite extreme, and use merely a piece of pipe for a burner, with nothing but a tee on the back to receive oil and air. Such a burner works all right under load, but is very cranky to regulate. The writer favors an open oil system, with two burners to each furnace, one an inside mixing type adjusted to hold a small flame, and the other as simple as possible for heavy work, and with no complications except a simple tee valve shut-off for each burner and central control. The small burners to be on a separate line and controlled separately, so that the small flames can be controlled for standby, to keep the bricks hot, yet keep the safety valve from popping.

The draft is an important point. It should be distributed all over the flame, coming from the grate bars preferably, especially with a flat flame; but a round or conical flame should take some air all around the burner, but not all here, else the flame will be too hot near the front, with the heavy draft and intense combustion near the burner. The amount of draft is just right when the stack smokes just a trifle, barely enough to see, as then there is no excess of air, and it is better to have the heavy smoke than to have a great air excess, since the excess air carries much of the heat up the chimney. Another way of telling if the draft is right is by the color of the flame tip. If it is a bright pink it is all right, but if a clear white there is too much air, and if smoky too little.

There are so many burners that instead of reviewing them the principles will be gone over and then a type of each described. The combustion of oil consists, first, of atomization, next, vaporation of each minute particle of oil by the heat of the flame, or reflected heat of the hot brick; next, the combustion of the vapor, and last, the combustion of the minute particle of coke. If there is not enough air this coke is not consumed, and it appears in the form of black smoke at the stack. If still less air is admitted, unburned vapors, tars and steam appear at the stack in the form of heavy brown and white smoke of very dense character. If no air is admitted, and the oil keeps spraying on the hot brickwork, as sometimes happens by accident, dense vapors of a steam-like appearance come through the stack. If, now, the air be turned on, without turning off the oil, an explosion takes place, known as a "back fire," and the flame will roar out into the fire-room, but seldom does any damage unless something inflammable or a person is directly in front. The draft is distributed as much as possible, part going in around the burner and the rest at all points under the bars. It is regulated by a shutter around the burner and the ash-pit doors or their equivalent. A quiet draft, quiet fire and enforced combustion should be the conditions for average marine boilers. Forced draft, admitted only around the burner, and strong atomization produce intense combustion, high temperature, much localized conditions which are not wanted in marine work.

Fuel oil will, on the slightest excuse, drop carbon and asphalt; the principal cause of this being overheating, say to 400 degrees F. or more. Experiment has shown that any burner which preheats the oil by direct application of fire is impractical on account of rapid carbonizing, hence this feature will not be discussed. Heating the steam or air by running a loop into the furnace is practiced a good deal with good results, but is wholly unnecessary. If carried to excess the

atoms of oil will be over-vaporized and will "star"; that is, the flame will appear exactly as though pieces of iron were burning in it, and much carbon will be thrown down and not burned. Right here a word of caution should be sounded to all experimenters, to the effect that there is no economy, theoretically, in adding heat to either air, steam or oil, except to make the oil flow more easily, and practice has condemned as a failure all burners that preheat the oil to vaporization in any way, as the apparatus promptly carbonizes.

Dangerous flare backs are due entirely to oil leaking into the hot furnace, and vaporizing, then suddenly taking fire. They usually occur from imperfect atomization, due, in turn, often to carbon or asphalt on the end of the burner. The only danger of a flare back is setting fire to something, or personal injury, and the remedy is to shut the oil off and put the burners in proper condition. Flashing or puffing is due to a construction of burner that permits a few drops of oil to collect in some fitting or pocket within the tip, and being blown out periodically, imperfectly atomized. Very bad cases will cause flare backs.

Starting an oil fire in a cold furnace is very easy with a good burner. In large plants, the steam or air comes from a coal-fired donkey boiler. In small harbor plants there must be provision to burn both coal and oil. The writer has often thought of a system including a small tank on deck to operate a small Koerting pressure burner by gravity for starting purposes, but has never seen it tried out. A burner that atomizes well will hold a suspended flame in a cold furnace if the lighter fuel oils are used, but no kind of a burner will hold a suspended flame with very heavy unheated oils, and no ordinary fuel oil can be lighted and burned in suspension if a rough burner that does not atomize finely is used. In such cases a coal or wood fire will be used and the oil sprayed directly into it. Whenever there is difficulty in firing up a heavy plant, or if one is in a hurry, it is a good plan to start a good coal fire in each furnace, and then the burners may be turned on as heavily as wished, remembering, of course, that oil can be forced much more than coal, and if overdone with a cold boiler, particularly of the Scotch type, will set all the tubes to leaking.

Most installations provide a target of firebrick, either built up of loose, broken pieces of the flame to impinge on, to steady the heat and to insure combustion in case the flame does not suspend. The best recent practice eliminates the target, but surrounds the flame with white hot brickwork and provides a burner that will suspend at all times under all conditions, except with cold oil of a gravity that cannot be atomized. The hardest thing for the novice to get is the suspended flame. He will make the oil burn by impact on hot brick or burning coal, but it takes some skill and adjustment to get a clear flame suspended from the burner in a cold furnace. It depends upon perfect atomization, not too much air or steam, not too much oil, and carefully regulated draft. Once the furnace is hot the flame will suspend under almost any conditions if the installation is right.

The tip of the flame is the point of maximum temperature, and, because of fuel and blast, is hotter than a coal fire and must not be allowed to impinge on any part of the boiler or brickwork, as it will quickly destroy either. It must not be long enough to reach the tubes, as combustion ceases there and unburned products are wasted in the chimney gases in the form of unburned coke and hydro-carbons.

The length of the flame depends upon the pressures employed and the draft distribution. The shape of the flame depends upon the burner used. The conical flame is the least economical, because the air does not easily reach the interior. Experienced experts are of late adopting various forms of flat flames spread completely over the grate bars or

source of draft. Most of the draft is admitted through large areas and distributed gently on the under side of the flame, with a very little, if any, admission over the flame. Conical, barrel, whirling and similar flames are now mostly replaced by flat flames, even in Scotch furnaces; actual tests being in favor of the latter. The most important feature in the shape of the flame is that the air shall reach all parts without there being an excess. All boiler flames are more or less limited in length, compelling a somewhat intense combustion and very little volume or time for mixing air and oil, and with flames of large body filling the furnace it is not possible to get complete combustion without great excess of air. Recent flat-flame burners, made to the order of an oil expert, developed full power with 12 percent excess air and less than 1 percent steam consumption. Relative to the draft, it is proper to state that for every 100 percent excess of air will be burned 10 percent additional fuel.

The various burners have the following parts and functions:

First, and most important, regulation of the air or steam pressure. This is most important and is usually accomplished by an ordinary globe valve at each burner, or a central globe valve for central control systems. It is not used to control the flame, but is a necessary adjunct of the adjustment for atomization. The spray needle running to the orifice is almost abandoned now as a method of adjustment, but many burners have a wire that is meant for cleaning purposes only. The proportion of the orifices, etc., is purely a matter of experience, but in general, it may be said that the oil port is of minor importance, but the shape and size of the final issuing hole or slot is the making of the whole burner. It shapes the flame, determines the capacity, and is the important part of all.

The fire is regulated by regulating the oil. On single burners, or old style installations, a double connection is provided that shuts off both the oil and air with one lever, but late practice embodies central control of the oil pressure, with attachments to each furnace for adjustment only, or the cutting out of a boiler. The flame may be horizontal, vertical, or at an angle. It may be shot from the front in, as in a Scotch boiler, or from the back forward, as in a locomotive type, or from above down, as in a Babcock & Wilcox boiler, or from the bottom up, as in a Thornycroft.

The test points and characteristics of a good, oil-burning plant include ease of starting with cold furnaces. This is the hardest test on the really fine points of a burner, and is the situation in which the difference between a burner and two pieces of pipe show up. It must carry a suspended flame. It is a poor installation that depends on a target or bed of coal to keep the oil burning. One expert suggests to use lighted waste, but simply lights his burners with a match or candle, and the writer has seen them burn in a cold furnace with a flame only 12 inches long, which could instantly be lengthened out to as many feet. The plant must give a small flame with out going out, and it must endure all possible regulation from central control without going out. It must not be too sensitive, which is a fault of most burners that atomize at high pressures. It must not throw down carbon, which is a fault of most burners when crowded, particularly with large, solid flames, and is due to the air not reaching all parts of the flame. It must not smoke, nor must it require more than 25 percent excess of air, and it is possible to run with 10 percent excess. There should be a low stack temperature with any rational boiler installation. Excessive heat should not be radiated through the front of the furnace into the fire room.

The flame must not star, which is due entirely to overheating either the air, steam, oil, or a long, hot burner. Let it be emphasized here again that the mistake most novices have to be educated out of by hard experience is the applica-

tion of too much heat to the oil before combustion. It always makes trouble and burns no better; in fact, will throw down carbon instead. The flame must not impinge on the boiler parts anywhere, and preferably not on the brickwork. The sides of the flame do no harm, but it must not strike directly. It should burn quietly. The principal cause of noise is high pressure and imperfect atomization. It is possible to get perfectly quiet combustion, except in furnaces that are small for the work, but it takes careful adjustment and first class installation.

A good burner will not flash back, because it will burn all oil in suspension and will not drip any. It does not sputter. Sputtering is caused by moisture in the oil, or wet steam, or both; but in a correct installation the oil is separated from the water, and the steam is dry.

Most oil-burning installations involve the making over of coal-burning furnaces. If experts are not available there is no reason to hesitate to make such an installation. In such a case the first thing is the target. It is preferably of loose pieces of broken brick for the oil to impinge against. It is not necessary where a high-grade installation is made, but should always be used where the installers are not thoroughly familiar with oil fuel. The brickwork should surround the flame and keep it from impinging on the boiler; at the same time, too much heating surface must not be covered. The draft should be distributed as much as possible over the flame, and so arranged that it cannot pass the furnace without going through the flame. It may be preheated by passing through hot grate bars, or heated ducts under the brick, but it does not pay to make any heavy investment to preheat the draft air, since extremely high temperatures are not wanted in boiler furnaces, and preheating is not a factor of economy if the installation be correct, unless the air be preheated with waste heat, as in the Howden system, which has never been tried yet with oil, since oil fires without blowers can be forced beyond the boiler capacity, but undoubtedly economy would result. The shape of flame should be such that no air can pass around it, and yet all parts of it can be accessible to fresh air. The length does not matter, so long as it does not impinge on the boiler, and so long as all the fuel is properly consumed.

Many installations require that the change to coal burning shall be made with ease. This is a matter of mechanical judgment, and does not require expert knowledge. Usually, the grate bars are left in place in this case, and are merely protected with a layer of brick.

In designing for oil exclusively, as with a new boiler, a stack slightly smaller than that for coal will answer. The following evaporations may safely be counted on per square foot of heating surface:

Scotch, 5 pounds of water per hour from and at 212 degrees Fahrenheit.

Hohenstein, 6 to 14 pounds (according to draft).

Babcock & Wilcox, 4 to 7 pounds.

Stirling, 4 to 7 pounds.

Plain cylindrical, with small tubes, 5 to 5.5 pounds.

The first figures give the conservative ratings for all boilers, and the second the maximum safe limits. No high limit is given for the Scotch, since they are designed usually to operate at pretty high rates of evaporation, and any pushing is apt to bring down the crown sheets, especially as 5 pounds is rather high, but if the circulation is known to be good and the furnace sheets are clean the boiler may be forced to do as high as double duty, but the furnace sheets should be watched every minute to see the color, and they should not be allowed to glow at all, nor even to scale, which can always be ascertained by the sparks from the scale as it drops into the fire, which, however, must not be confused with starring. Starring consists of millions of sparks, while scale

makes just a few, where the bits of scale drop from the top of the furnace into the fire.

The heating surface per horsepower should be proportioned to the evaporation, and not taken at any rough commercial rating. With Scotch boilers and triple expansion engines of modern design, and say 150 pounds pressure, it is customary to allow 3 square feet of heating surface to the engine horsepower, but this includes auxiliaries, port duty and all, and is a rough commercial rating only.

As to the amount of oil used, it is almost impossible to compare it to coal, as the calorific value of coal varies from 9,000 B.T.U. per pound to 14,000; besides, it is impossible to burn some coals efficiently because of caking and clinking, and there is always a loss due to cleaning fires, while oil runs uniformly at 18,000 heat units, and burns with uniform efficiency. However, it has been found that three barrels of oil are equal to 1 ton (2,000 pounds) of the poorest Western coal, 4 barrels of oil are equal to one ton (2,000 pounds) of the best Eastern coal. The following actual boiler efficiencies have been made by test:

TYPE OF BOILER.	Efficiency with Coal,	
	Anthracite, Percent.	Efficiency with Oil, Percent.
Plain cylindrical	71.3	74.7
Hohenstein natural draft.	64.4	65.6
Forced draft	59.5	56.7
Scotch	78	82
Babcock & Wilcox.....	..	83, at 3.85 pounds evaporation. 74, at 7.1 pounds evaporation.

To operate the burners takes from 1 percent or less to 4 percent, and even more of the steam generated, depending upon the grade and character of installation. If compressed air be used, from 30 to 100 cubic feet per pound of oil are required, depending upon the system used. It is more correct to give it in terms of power, and still more correct in terms of heat units via compressor, etc. By steam, direct, it may be taken as 1 to 4 percent. By air, the heat units can be reduced to a negligible amount, particularly if the compressor be attached to the main engine, or otherwise economically operated, but less than 1 percent is always obtainable, particularly with modern low-pressure systems.

The evaporation per pound of fuel, from actual tests, is as follows:

TYPE OF BOILER.	Pounds of Water.
Scotch	14
Plain cylindrical	14.75
Locomotive	13.25
Hohenstein	13.8
Babcock & Wilcox	15.85, at 4 pounds evaporation. 14.1, at 7 pounds evaporation.
Stirling	13.8

The furnace should allow for a flame length of at least 8 feet, and more if possible.

In making oil fuel computations, the following data will be of use:

One gallon of oil equals 8 pounds; 1 pound of oil equals 18,000 heat units; 1 barrel of oil equals 42 gallons; 1 barrel of oil equals 336 pounds; weight of oil equals 60 percent weight of coal; storage space for oil is 56 percent that for coal; 100 barrels of oil equal 560 cubic feet.

Scotch boilers are usually arranged for fuel oil by removing the grate bars, and lining the lower half of the furnace with firebrick. Across this, at right angles, are placed two dams of checkerwork, or broken pieces of brick. The flame is pitched downward and passes through the checkerwork, and while radiating its heat to the top of the furnace does not impinge upon it. The entire combustion chamber is lined, until recently, since suspended flames have been so perfected the practice is being gradually abandoned.

Plain cylindrical boilers are fired by protecting with brickwork, and shooting the flame on a target placed at about the bridge wall, and covering the grate bars with brick. If the boiler is designed from the first for oil the burner is placed at the back of the furnace, and the fire is carried in a long, white-hot tunnel, and the ingoing air is preheated in brick ducts

under the furnace; a practice of doubtful value. At the end of the tunnel, near the furnace front, the flames reverse and pass under the boiler proper.

Locomotive type boilers are fired from the back and bricked half-way up to protect the water legs and make radiation surface around the flame.

Babcock & Wilcox and other watertube boilers are fired in many ways, but, in general, the grate bars are removed, the flame is flat and shoots in any direction so long as it does not impinge on parts of the boiler, and the draft is evenly distributed so that it all has to pass through the flame.

THE NORTH LAND.

On April 5, 1910, the Maine Steamship Company placed a fine new steamer on the route between New York and Portland, Me. This new vessel, which is a handsomely modeled, compactly arranged and well ventilated steamship, was designed and built by the Harlan & Hollingsworth Corporation, Wilmington, Del. She was completed in the short time of seven and one-half months from the date of laying the keel to the date of sailing on her first voyage. This is a good record for rapidity of construction, considering the many snow storms and the amount of bad weather experienced this last winter. The amount of joiner work to be erected can readily be estimated from the drawings and photographs published herewith.

The *North Land* is 330 feet over all, 47 feet molded beam, 28

and tied by steel stringers and tie plates. The decks are supported by steel channel girders having wide-spaced steel pillars. The superstructure is entirely supported by steel, a steel bulwark extends around the saloon deck, terminating in a steel forecastle extending to the promenade deck. The bulwark is stiffened by channel stanchions, which extend to hurricane deck, carrying steel frieze plates at the promenade and hurricane decks. The customary turned wood rail stanchions have been dispensed with and steel substituted, thus giving the vessel a clean and neat appearance which has been commented on by many in New York and Portland. Freight is taken on board through two very large cargo ports on each side of the main deck level, from thence it is conveyed to the holds by two double elevators, operated by hoisting engines of Williamson Bros.' make. The vessel will carry a deadweight of 1,700 long tons, and as her stay in port is only twenty-four hours every facility is provided for the expeditious discharge and loading of cargo. Her bunker capacity is such that sufficient coal can be carried to make two round trips. Fresh-water tanks are provided for boiler feed and for galley and passengers' use.

The vessel has 180 staterooms in addition to those provided for officers, petty officers, wireless, etc. Seven of these are large bedrooms, having tastefully paneled walls, with built-in mirror panel, brass bedstead, etc. Twenty-nine of the larger staterooms are fitted with brass beds and arranged with communicating doors, so that they may be used en suite. One noticeable feature of the arrangement is that all staterooms—with exception of two—are entered from inside. The rooms which do not have outside windows are splendidly lighted and



NEW STEAMER NORTH LAND, BUILT BY HARLAN & HOLLINGSWORTH FOR THE MAINE STEAMSHIP COMPANY.

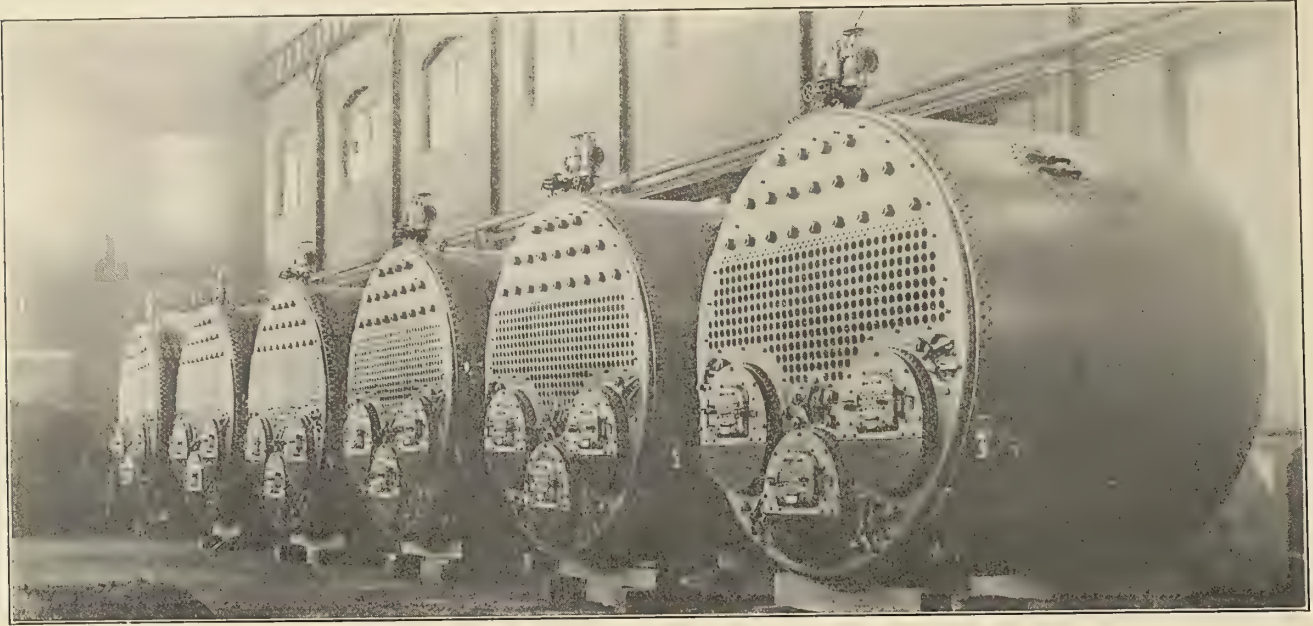
feet depth to saloon deck, with a load draft of 17 feet. The decks below the saloon deck are the main and lower decks, and above the saloon deck the promenade and hurricane decks. The vessel is built of steel, with scantlings, to comply with the American Bureau of Shipping Rules; she is divided transversely by seven steel bulkheads, five of which are watertight, and a continuous cellular double bottom extends from the aft peak to the fore peak bulkhead. Athwartship wells are left in the double bottom in the engine room and at the end of the shaft alley. The tank top is made tight over these wells, and valves are fitted for bilge drainage to same, so that in the event of the bottom of the ship being punctured in the well space the safety of the vessel would not be endangered.

The main deck is entirely plated with steel, the lower and saloon decks are partially plated, while their ends are bound

ventilated by skylights, which can be opened or closed from within.

The builders have made a decided departure from the customary internal arrangement of coastwise vessels, where the staterooms are usually arranged around a large open saloon, curved parallel to the side of the house line. In the *North Land* ample sitting and lounging space has been obtained by substituting large hallways at each stair landing, and by a commodious social hall on the hurricane deck instead of the long, narrow curved saloons as heretofore. The passengers have already expressed their approval of this arrangement, as a splendid view can always be obtained in bad weather, which was not possible with the inside saloon.

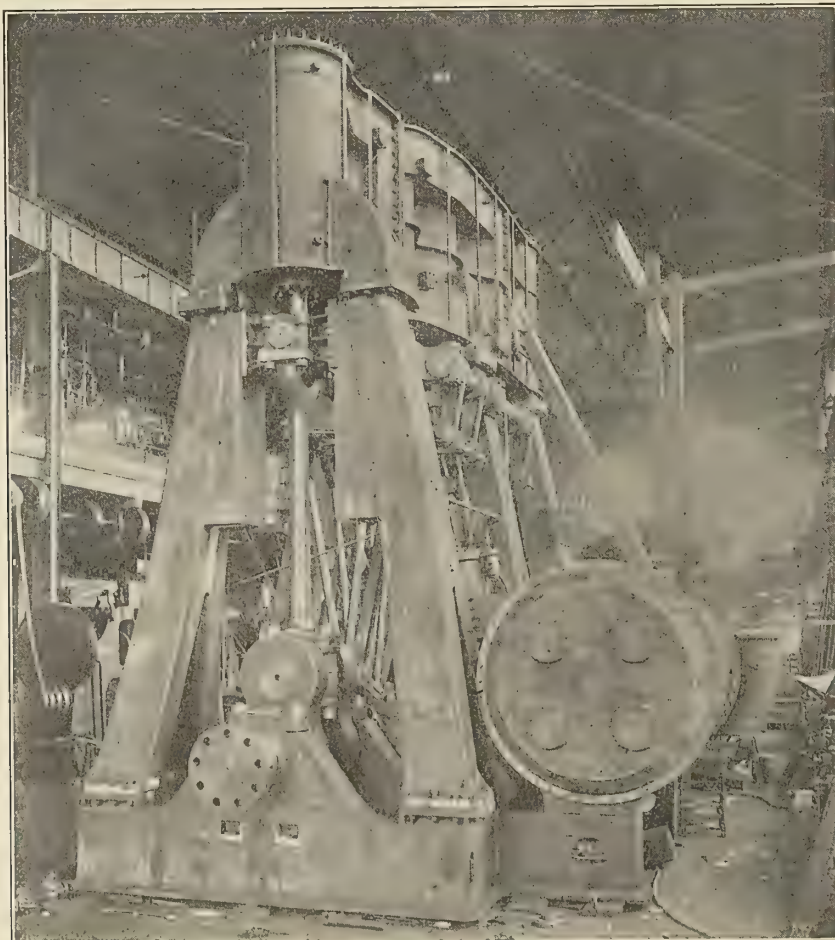
The main hall or entrance on the saloon deck is a large space, the floor of which is covered with interlocking rubber



THE NORTH LAND'S MAIN BOILERS, ERECTED IN THE BUILDER'S SHOPS.

tile of a quiet design by the Pennsylvania Rubber Company. The newsstand is located in this hall. The dining saloon is on this deck, and has a seating capacity for 132 passengers; over the dining saloon is a central light and air well, lighted by a skylight on top of hurricane deck house. The paneled

walls of this room are finished in ivory white with slight gilt relief, the furniture is of mahogany, the upholstery and carpet being of a dark red shade. The room is well lighted by ceiling fixtures, and the tables have adjustable silver electric lamps with red silk shades, all contributing to a very restful, warm



MAIN ENGINE AND CONDENSER OF THE NORTH LAND.

and pleasing effect. The pantry and galley are located directly abaft the dining saloon on the starboard side and the bar-room on the port side, with the chief steward's room abaft same. The galley and pantry are perfectly ventilated by outside windows and vertical shafts leading to the hurricane deck. It has been particularly noted that no smell of cooking was noticeable in either the dining saloon or the passenger quarters.

A large stairway leads from the dining saloon and from the after hall to the promenade deck landing in commodious halls, while over the former a stairway leads to the social hall on the hurricane deck. These stairways are of mahogany, neatly and substantially constructed. The newel posts and the steel pillars supporting the dining saloon well, being finished in the same style, are further ornamented by a wreath of electric lights. Balustrades, mirrors, rubber treads, brass plates and builders' name plates of very simple and tasteful design complete the finish of these stairways. The carpet of the promenade deck is of green shade, as is the upholstery in the lounging spaces, giving a restful effect.

The social hall, or music room, on the hurricane deck, is one of the features on the *North Land*. This is a commodious apartment, which can be reached from any part of the interior without necessitating—as is often the case—running the gauntlet of rain or wind across some exposed deck. In the center of this social hall is the well which lights the dining saloon. The piano and furniture of this room are of dark mahogany, the lounges, chairs, etc., are upholstered in red leather, and the floor is covered with carpet of a shade which harmonizes with the whole. The walls are paneled and finished in ivory white with gilded pilasters and caps. This apartment has doors on either side opening on to the hurricane deck, and at the fore end doors opening into the smoking room. This hall is lighted by two skylights and the side and end windows, from which a splendid view may be obtained.

The smoking room is an ideal spot, with a complete toilet room opening off same. The smoking room walls are paneled in stained oak, the seats are upholstered in dark green leather, the floor is covered with a mosaic tile inlaid linoleum imported from Germany, and used in this case for the first time on shipboard. This room has six card tables with linoleum tops and oak framing, and is lighted and ventilated by side and end windows and overhead skylight.

The officers' rooms and pilot house are located forward of the smoking room. Communication is maintained for emergency in bad weather by an interior stairway leading from the pilot house to the promenade deck. A toilet is fitted for the officers' use opening into the pilot house. The captain's room is handsomely finished in oak and is adjacent to the pilot house, opening into it. A house for wireless telegraph is located between the smoke funnels, and fitted with a Pullman bed for the operator. The carpentering and upholstery work on this vessel was done by the builders at their works.

The hurricane or boat deck is used entirely for passenger promenade, except the small space which is occupied by boats, skylights and houses. Access to this deck is obtained from three points—one aft, one forward and through the social hall. The arrangement of toilets is very satisfactory, as every deck is provided with them, and all are centrally located, well equipped, lighted and ventilated, as can be seen on the plan. Three drinking wall fountains are fitted in convenient places, where ice-cooled drinking water may be had. The sanitary piping on the *North Land* is all of brass, while the bilge and ballast piping is of cast iron and lead.

The vessel is lighted by electricity, and has a powerful searchlight. The electric fixtures are neat and attractive, all being fitted with frosted bulbs. The running lights and compasses are also lighted by electricity, and a tell-tale apparatus is fitted in the pilot house.

The life-saving appliance consists of eight metallic lifeboats,

four metallic rafts and a working boat. The boat davits are of a new type, in which the upper block is part of the davit itself. Seven hundred and twenty life preservers are stowed around and eight life-ring buoys. Fire outlets and hose are found on each deck, and are in excess of requirements. Communication between the pilot house and the engine-room is by means of a Corey telegraph; telegraphs are also used for docking the vessel. Speaking tubes and telephones are also fitted between important points in the vessel, and the usual electric bells and annunciators are in evidence.

The vessel has a steam steering gear of Williamson Bros.' make, also an independent hand-steering gear, a hand-screw gear aft and emergency relieving gear. The anchors are of the stockless type, stowing in the hawse pipes. The windlass is of the American Ship Windlass Company's make, and is also used for warping the ship. The steam warping capstan at the aft end has been supplied by the same company.

The propelling machinery consists of one set of triple-expansion engines, having cylinders 28½ inches, 46 inches, 75 inches diameter by 54-inch stroke. The working steam pressure is 180 pounds per square inch. The cylinders are supported, back and front, upon cast iron inverted "Y" columns. The crank shaft is of the built-up type, being in three interchangeable sections. The propeller is solid, having four blades, and is 16 feet diameter. The valve motion is of the ordinary Stephenson link type. The condenser is cylindrical, of steel plate and independent of the main engine framing; it contains 6,000 square feet of condensing surface. The air and bilge pumps are reciprocating, being worked from the cross-head of the main engine. All other pumps are independent.

The main boilers, six in number, are of the cylindrical return tube type, 13 feet 8 inches diameter by 11 feet 6 inches long, each containing three furnaces. The total heating surface is 13,692 square feet, and the total grate surface 390 square feet. There are two stacks, and special ventilation is provided in the fire-room, having, besides four large ventilators, a blower with distributed air outlets. A donkey boiler for auxiliary purposes, 9 feet diameter by 10 feet long, is located on the main deck. An ejector and special pump are provided for handling ashes.

A POWERFUL STERN WHEEL TOWBOAT.

The stern wheel towing steamer *Gamecock*, recently completed in Joseph Supple's Shipyard, at Portland, Oregon, for the Willamette & Columbia River Towing Company, deserves special mention as an example of the latest improved type of stern wheel steamboats designed for heavy towing.

Portland has a lumber output greater than that of any other city in the world. The cut last year amounted to 610,000,000 feet. All the raw materials for this large output come from logging camps scattered along the Columbia River and its tributaries, and the logs are towed in rafts to the mills on the Willamette River at Portland. The logging district extends from 10 miles below the mouth of the Willamette River to the bays at the mouth of the Columbia River, a distance of about 90 miles. The mills at Portland are located 12 miles up from the mouth of the Willamette River, so that the longest tows are a little over 100 miles, all up stream and against an average current of 3 miles per hour, which increases to over 5 miles per hour during flood stages. The *Gamecock* will handle from one million to two million feet of logs per trip, gaging her tow to meet the condition of the current. The rafts in a tow of large size are in three and four sections, each about 500 feet long. The tow line is usually run out about 1,000 feet, so that the aft end of the raft is over a half a mile from the stern of the towboat.

The Willamette & Columbia River Towing Company have

CONSTRUCTION DETAILS.

The stem is of oak, molded 16 inches, sided 12 inches, strongly reinforced by deadwood, and a natural crook apron. The frames are of Oregon fir 4 inches, double flitch, sawed to form, spaced 22 inches centers. The keel is of 5-inch by 12-inch fir, and the forefoot of oak. The transom is 4 inches thick; the bottom planks $3\frac{3}{4}$ inches thick; top side planks $2\frac{3}{4}$ inches thick. In the main keelson two strakes are of 8-inch by 14-inch fir, and one strake 8 inches by 16 inches. The outer keelsons are two in number, each of two strakes of 8-inch by 16-inch fir. The sister keelsons are two in number, each of three strakes of 8-inch by 14-inch fir. All timbers for keelsons are in not less than 50-foot lengths. The boiler keelsons are of two strakes of 12-inch by 20-inch fir 60 feet long.

The deck beams are of 5-inch by 6-inch fir to camber, increased to 5 inches by 8 inches and 5 inches by 12 inches forward and under the capstan. The sheer strake is in two pieces, each of 4-inch by 8-inch fir. The clamp is in two pieces, each of 3-inch by 8-inch fir. The knuckle strake is in three strakes, each of 4-inch by 8-inch fir. The main deck is of 3-inch by 6-inch tongued and grooved fir. The nosing is of 4-inch by 9-inch oak. The cylinder keelsons are of four strakes of 10-inch by 18-inch fir, 50 feet long. The forward buffalo is of 10-inch by 12-inch oak 12 feet long. Of the hog posts the forward king post is 12 inches by 12 inches by 32 feet long, the center king post is 20 inches by 20 inches by 50 feet long, the forward side posts are 10 inches by 10 inches by 32 feet long, the after side posts are 10 inches by 10 inches by 31 feet long, and the wheel posts are 8 inches by 8 inches by 14 feet long. All posts have heavy step timbers reaching athwart all keelson strakes, and the posts are stepped into oak plates. A very heavy system of hog rods, with turnbuckles in each section, extends over the various sets of posts, thus keeping fore and aft alinement perfect.

The center king post is set on the center line a few feet aft of the fore and after center, and carries a swinging block on the after side near the top, which guides the wire towline down to the towing engines on the main deck. These engines keep a constant strain on the line and take it in if the boat backs up. Placing the pull at this point enables the boat to be easily controlled by her rudders.

The guard overhangs 2 feet alongside and holds its width well up forward. At the waterline the hull is protected by a strake of galvanized iron sheathing, to prevent chafing against floating obstructions.

As the boat is not intended to carry passengers, provision is made for quarters for the crew only, consisting of a full freight house, containing machinery and accessories, with a half-cabin on the boiler deck and a pilot house and short texas on the hurricane deck. All are built of unusually strong framing, reinforced by natural crook knees. About 175,000 feet of lumber were required in the hull and houses.

PROPELLING MACHINERY.

The propelling machinery is unusually powerful, and capable of withstanding the most severe usage. The engines are direct-acting, of the usual stern wheel type, with cylinders of 18 $\frac{3}{8}$ inches bore and 84 inches stroke, with counterbalanced slide valves. The shaft is of nickle steel 10 inches in diameter. The cylinder "timbers" are spiral rolled steel I-beams 15 inches deep by 6 $\frac{1}{2}$ -inch faces, weighing 80 pounds to the foot. The inner beams are 60 feet long and the outer 51 $\frac{1}{2}$ feet long. The outer beams are bent in at the after ends and secured to the inner beams by steel brackets.

These beams and their settings are special features, designed to avoid trouble which has arisen from racking the engine settings. The I-beams are set on oak bases, which are notched over the deck beams in two parts—one above and one

below the deck beams, clamping them firmly and holding them rigid by wedges. At intervals of 3 $\frac{1}{2}$ feet iron lugs are riveted on to the lower faces of the I-beams. These lugs are set in sockets in the oak, cut wide enough to admit a wedge on each side of the lug. Thus, by wedging up all slack of the oak on deck beams, and by wedging taut the lugs in the oak bases, it is expected there will never be any fore-and-aft movement of the I-beams. This method of setting the cylinders is entirely novel, and considerable interest is taken in the result. The cylinders are secured through the I-beams and keelsons in the hold, with turnbuckle bolts in a very substantial manner.

The boiler is of the locomotive fire-box type, 76 inches diameter of shell, containing 217 tubes 2 inches by 18 feet, and is allowed 175 pounds steam pressure. It provides ample steam for the engines and accessories when doing the heaviest possible duty.

Crude oil is burned for fuel, and a supply is carried in six cylindrical steel tanks in the hold, having an aggregate capacity of 380 barrels. This large supply is necessary, as at times it takes five days to reach the tow and return with it.

The steering gear consists of four main rudders secured to the transom and two auxiliaries, or "monkey" rudders, attached to the fantail aft of the wheel. The pilot is aided by a steam steering gear of the "short gun" type.

The propelling wheel is 20 feet in diameter, with buckets 22 feet long by 30 inches wide, dipping from 30 to 36 inches, according to the trim of the hull. This extreme depth of dip is necessary on a boat which exerts its maximum power when producing only a very moderate forward motion.

The boat is completely equipped with electric lights, and has a searchlight of 3,000 candlepower.

In spite of her massive construction, the lines of her hull are graceful, and she shows good speed when running without a tow, and presents a pleasing appearance when in service.

When completed the *Gamecock* represents a value of \$40,000 (£8,218), and is claimed to be the staunchest boat of her class in this port.

EFFECT OF SHIFTING CARGO.

BY ARTHUR R. LIDDELL.

The effect on the stability of a vessel of the removal of a weight from her center line towards one of her sides is, in a general way, well understood, but the extent of the loss of righting power which this represents is not always quite realized.

Assume that a steamer of 240 feet by 33 feet 6 inches by 19 feet has a *GM* height of 12 inches, with a homogeneous cargo of grain. In this condition she may have a curve of levers, as shown in Fig. 1, by the full line, which cuts the base at about 47 degrees.

Now, assume the cargo shifted, so that the center of gravity *G* is raised by the amount $GG_2 = 1$ inch further from the keel and moved by the amount $G_2G_1 = 2\frac{1}{4}$ inches to starboard to the position *G*₁ in Fig. 2.

For the angle of heel α the reduction in length of righting lever, due to the raising of *G* to the position *G*₂ is equal to $GG_2 \sin \alpha = 1 \sin \alpha$ in inches. The full upper line being the original curve of levers, as above observed, the corrected line for the raising of the center of gravity is shown dotted just below it. At 90 degrees the reduction of positive or increase of negative leverage equals 1 inch.

The lateral movement of *G* to *G*₁, represented by the line *G*₂*G*₁, reduces the lever by an amount equal to *G*₂*K*, which is equal to $G_2G_1 \cos \alpha = 2\frac{1}{4} \cos \alpha$ in inches, while at other points along the stroke-and-dot line the reduction of positive

or increase of negative leverage varies with the cosine of the angle, so that it becomes $2\frac{1}{4} \times 0 = 0$ at 90 degrees.

The stroke-and-dot curve in Fig. 1 represents the condition with cargo shifted, and is drawn for both sides of the vessel. The range of stability, which originally extended from 0 to 47 degrees, has been reduced by the shifting of the cargo to one extending from 10 to 41 degrees, *i. e.*, by about one-third and the height of the curve, or length of the longest lever, is now only $1\frac{1}{2}$ inches, instead of about $3\frac{1}{2}$ inches as originally.

The port levers are lengthened by the amounts by which the starboard ones are shortened.

If the vessel rolls 16 degrees to port, she will pass the upright position and heel to 8 degrees on that side. Inasmuch as the dynamical reserve of stability on her starboard side, represented by the area of the curve *ABC*, is less than that of the piece of the starboard curve *AD*, the return roll will capsize her.

For a seagoing vessel in ordinary grain-carrying trim, the list shown is a heavy one, but it is one that may occur, and it serves to illustrate the danger accompanying shifting of the cargo. It will be observed that a list of 10 degrees alters the

difference being that for sailing a sufficient reserve would usually be provided. The danger most resembles that which threatens a broad, flat-bottomed sailing ship in ballast, which, with a short range of stability, can carry a large spread of canvas on a comparatively light draft, but may in so doing have almost swallowed up her reserve. Such a vessel is uncomfortable at sea, and an unwary captain is apt to counteract this by taking in too little ballast and thereupon to disappear with all hands, leaving behind him one more unsolved mystery of the sea.

LAUNCH OF THE BATTLESHIP FLORIDA.

The United States battleship *Florida* was successfully launched from the Brooklyn navy yard, Brooklyn, N. Y., May 12. The *Florida* is a sister ship of the *Utah*, which was launched from the yards of the New York Shipbuilding Company, Camden, N. J., Dec. 23, 1909.

The keel of the *Florida* was laid in March of last year and the construction has progressed without delay in a most satisfactory manner until at the time of her launching she was

FIG.1 CURVES OF RIGHTING LEVERS

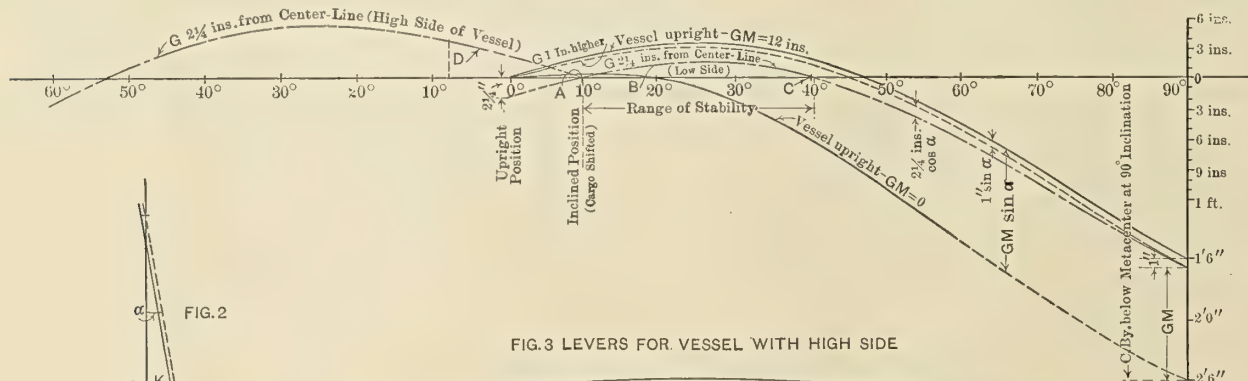


FIG.3 LEVERS FOR VESSEL WITH HIGH SIDE

CURVES ILLUSTRATING EFFECT OF SHIFTING CARGO ON THE STABILITY OF A VESSEL.

capsizing point from 47 to 41 degrees at the same time. Should the vessel list to 25 degrees, she would capsize then and there.

When cargo has shifted, the usual experience is, that after the vessel has once taken a list, she gradually heels over to a still greater angle. The causes of this are that the grain gradually settles, the feeders ceasing to do their work at the angle assumed, and, further, that bilge water and loose objects of all kinds gradually go over to the low side.

The case of a vessel with an exceptionally high side, or of a timber carrier in which a securely lashed deck load is practically part of the structure and represents an increase of its height, is different from the one just considered, in that the curve of levers has a much greater range—perhaps even extending past the inclination of 90 degrees. For such a vessel the curve may take the form shown in Fig 3.

She is theoretically incapsizable, but she may heel over to angles so great that she becomes unmanageable and inhabitable, or the deck load which then hangs from its lashing may break away from these—it may be on one side only, and the cargo, perhaps also the vessel, may be lost in consequence.

Figs. 3 and 1 further illustrate the safety in the one case, and danger in the other, of going to sea with a list. Within reasonable limits the narrow, deep vessel, with high freeboard may do this with comparative impunity, while the broad, shallow one, with low freeboard, would run a very grave risk.

The shifting of a vessel's cargo has nearly the same effect upon her as if a steady wind were acting on a suit of sails, the

about 69 percent completed. Viewed in comparison with the present Dreadnoughts of the American navy, the *North Dakota* and *Delaware*, the *Florida* is considerably larger, but not as speedy. Her over all dimensions are 521 feet 6 inches length and 88 feet 3 inches breadth, with a mean draft of 28 feet 6 inches when carrying a full supply of ammunition and a two-thirds supply of fuel and stores. On this draft her displacement is 21,825 tons. She carries 2,500 tons of coal and 400 of oil fuel. The outward appearance of the *Florida* will resemble greatly that of the *North Dakota*, with two smokestacks, two lattice observation masts and five turrets, each with two 12-inch 45-calibre guns, mounted on the center line of the ship.

The machinery installation of the *Florida* will consist of steam turbines and watertube boilers, together with the usual auxiliary machinery, electric lighting machinery, steam heating and evaporating plants, deck machinery and appurtenances for handling and maneuvering.

The turbine machinery will be of Parsons type, and will consist of ten turbine units on four shafts, and will be arranged in such a way that one high-pressure ahead turbine and one backing turbine (both independent of one another) will be placed on the outboard shafts, and the low-pressure ahead and backing turbines (in one casing), together with the high-pressure cruising turbine on the port side and the intermediate pressure-cruising turbine and a low-pressure ahead and backing turbine on the starboard side, will drive the inboard shafts. As in most of Parsons four-shaft arrange-

ments the outboard turbines turn inboard and the inboard turbines turn outboard. The engine room has a central fore-and-aft bulkhead dividing the engine power in two completely independent sections, each with complete sets of auxiliary machinery consisting of condensers, wet single-acting double vertical air pumps, centrifugal circulating pumps, main feed and other pumps, auxiliary condensers, etc. The twelve Babcock & Wilcox boilers will be placed in three watertight independent compartments, each with a double fire room.

The steam pressure at the boilers will be about 200 pounds, and 175 pounds at the throttle valve of the high-pressure turbines. As Parsons turbines do not operate advantageously

A NEW TYPE OF IRON ORE TRANSPORT.

BY F. C. COLEMAN.

One of the most interesting types of vessels now being used for the transport of iron ore is the steamship *Vollrath Tham*, which has recently been constructed to the order of the Rederiaktiebolaget Luleå-Ofoten, by Messrs. R. & W. Hawthorn, Leslie & Co., Ltd., of Hebburn-on-Tyne. The vessel, built to the British Corporation highest class, has a length over all of 390 feet, a length between perpendiculars, over stem and stern post, of 376 feet, a breadth of 56 feet 6 inches, a depth of 33 feet 6 inches, and a deadweight capacity of 8,000 tons. She has been fitted by the North Eastern



U. S. BATTLESHIP FLORIDA ON THE WAYS AT THE BROOKLYN NAVY YARD.

(Photograph by Muller.)

with superheated steam, the boilers are not provided with superheaters.

When running full speed the revolutions per minute of the turbines will be about 330, and the horsepower developed about 28,000. It is understood the trial requirements of the *Utah* and *Florida* are to be similar to those laid down in the case of the *North Dakota* and *Delaware*, which had one 4-hour full-speed trial, one 24-hour endurance and coal consumption trial at 19 knots, and one 24-hour endurance and coal consumption trial at 12 knots. The maximum speed required of the *Florida* is 20¾ knots in a run of 4 hours.

Marine Engineering Company, Ltd., with triple-expansion engines, and steam is supplied from three cylindrical multitubular boilers working at a pressure of 180 pounds per square inch. There are two powerful ballast pumps capable of delivering 600 tons per hour. On her trials the *Vollrath Tham* attained a speed of over 10 knots, and on the occasion of her maiden voyage, in ballast, from the Tyne to Narvik, the average speed exceeded 10½ knots.

The vessel has been specially designed to carry iron ore, with a view to quick and economical loading and discharging, and, in substitution for the ordinary holds, she has been divided into a series of hoppers and discharging holds. Before the

construction of the vessel was begun, a series of prolonged experiments were carried out at the Hebburn shipyard with a quantity of the actual ore, so as to ascertain the most efficient mechanical device for operating the doors; the correct angle of slope for the various ridges, the proper size for the shoots having previously been obtained from experiments

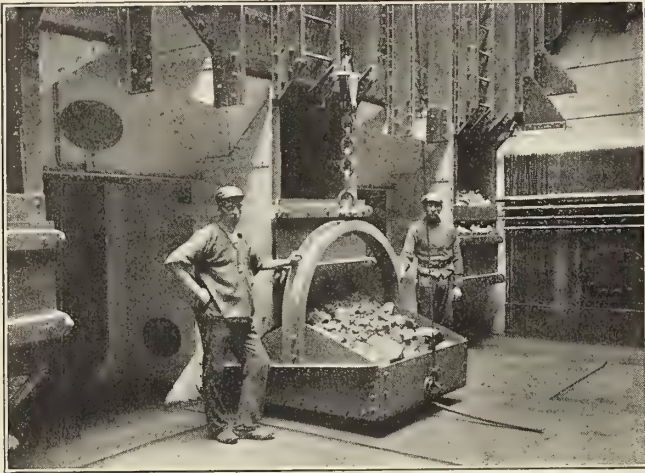


FIG. 1.—DISCHARGING HOLD AND ORE SKIP.

carried out in one of the ordinary vessels of the Rederiaktiebolaget Luleå-Ofoten. As a result, the hoppers are raised some distance from the tank top, and they have been constructed in a substantial manner, with bases sloping 42 degrees to the horizontal, the ore traveling to a series of four shoots, each of which is manipulated from the discharging holds. The door of each of these shoots is fitted with a lever, about 7 feet in length, and the door moves with a parallel motion eccentrically, thus relieving the pressure of the ore on the door, and permitting the door to be easily opened by one man. Upon the skip attached to the crane rope being lowered into position, the attendant is enabled, by operating the door lever, to arrange for the requisite

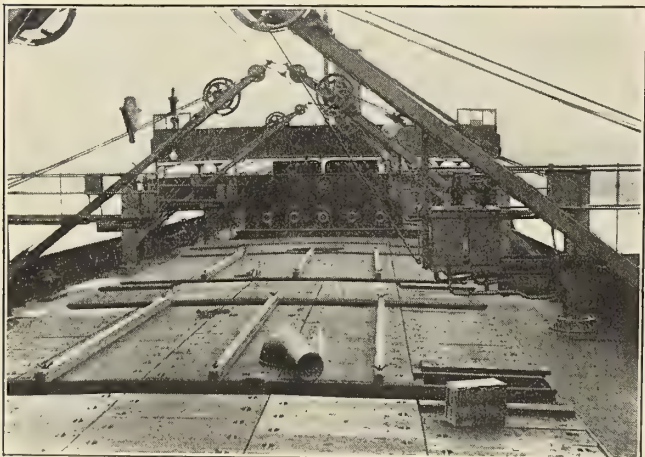


FIG. 2.—VIEW ON THE FORWARD DECK, SHOWING CRANES AND HATCHES.

amount of ore to travel into it. Thereupon, the door having been dropped, the bucket is drawn to the top, the crane-man having had the whole operation under his observation.

The hatchways, 2 feet 6 inches high above the deck level, are formed of continuous longitudinal girders divided by athwartship plates, and they were designed to suit the loading arrangements at Narvik, at which port the spouts are placed at intervals of about 13 feet. These hatchways being of somewhat unusual dimensions, special provision was made

for securing the covers by means of a number of wooden beams.

Having been specially designed for the transport of ore, the *Vollrath Tham* must necessarily perform half of the round voyage light, and has, therefore, been constructed to carry an increased amount of ballast, and has, in addition to the double bottom, been fitted with wing tanks, giving her a total capacity for water ballast of about 3,000 tons. As these wing tanks are required to support a great bulk of the ore, they have been built of very substantial scantlings and divided up at intervals of about 12 feet by complete or partial bulkheads. To maintain their watertightness against the falling of the ore, the tanks have been sheathed with 5½ inches of pine, covered with ¾ inch steel plate in the way of the ore hoppers, and, as the tanks are continuous, they give great longi-



FIG. 3.—CRANES DISCHARGING ORE INTO LIGHTERS.

tudinal strength—a matter of considerable importance in an ore vessel, owing to the irregular distribution of the loads.

The electrical equipment, both for power and lighting purposes and for the operation of the cranes, has been carried out by Siemens Brothers Dynamo Works, Ltd., Stafford. The generating plant and switchboard are fitted in a separate machinery room at the after end of the vessel immediately aft of the main engines. There are two duplicate generating sets, each consisting of a Brotherhood compound engine of the enclosed type, with forced lubrication, running at 400 revolutions per minute, and coupled direct to a Siemens multi-tubular compound wound generator, capable of developing 75 kilowatts at 220 volts. The electric lighting set comprises a Brotherhood engine, with forced lubrication coupled direct to a compound wound dynamo developing 64.5 amperes at 110 volts. The switchboard is divided into three panels, one for the lighting set and one for each power generating set, fitted

with automatic circuit breakers and change-over switches, so arranged that either generator can be used for working the cranes at either side of the vessel.

There are ten electric cranes, five on each side of the vessel, and each of these has a lifting capacity of $2\frac{1}{2}$ tons, with a speed of 75 feet per minute. The cranes are of a special type, having their mechanism all below deck level, and the post is fitted with gland end stuffing-box, so that the crane room is continuously watertight. On the side of the jib is fitted the operating platform, which is so arranged that the craneman is able to see all the movements of the skip when loading and emptying the same. The two controllers are together and they are fitted with one lever, which is so arranged that the load follows the direction of the movement of the lever. By the operation of a lever, which is within easy reach of the crane platform, the skip, which has a carrying capacity of

the after end of the ship, and amidships there is also a captain's room, while the crew are berthed forward.

The Rederiaktiebolaget Luleå-Ofoten is a transport company subsidiary to the Trafik Aktiebolaget Grangesberg-Oxelösund, of Stockholm, who, as one of the largest mining syndicates in Northern Europe, work the extensive iron ore mines at Gellivare and Kirunaavaara, in Lapland, which, together, produce more than one-half of the total amount of ore obtained in Sweden. By means of the Ofoten-Luleå State Railway, which runs alongside Lake Tornea, and is the most northerly railway line in the world, these mines have connections with the shipping ports of Luleå (Sweden) and Narvik (Norway). Narvik is a comparatively new port, and, although at latitude 68 degrees 26 N., it is free from ice all the year round. The Trafik Aktiebolaget Grangesberg-Oxelösund, of Stockholm, who annually ship from Narvik some two and a

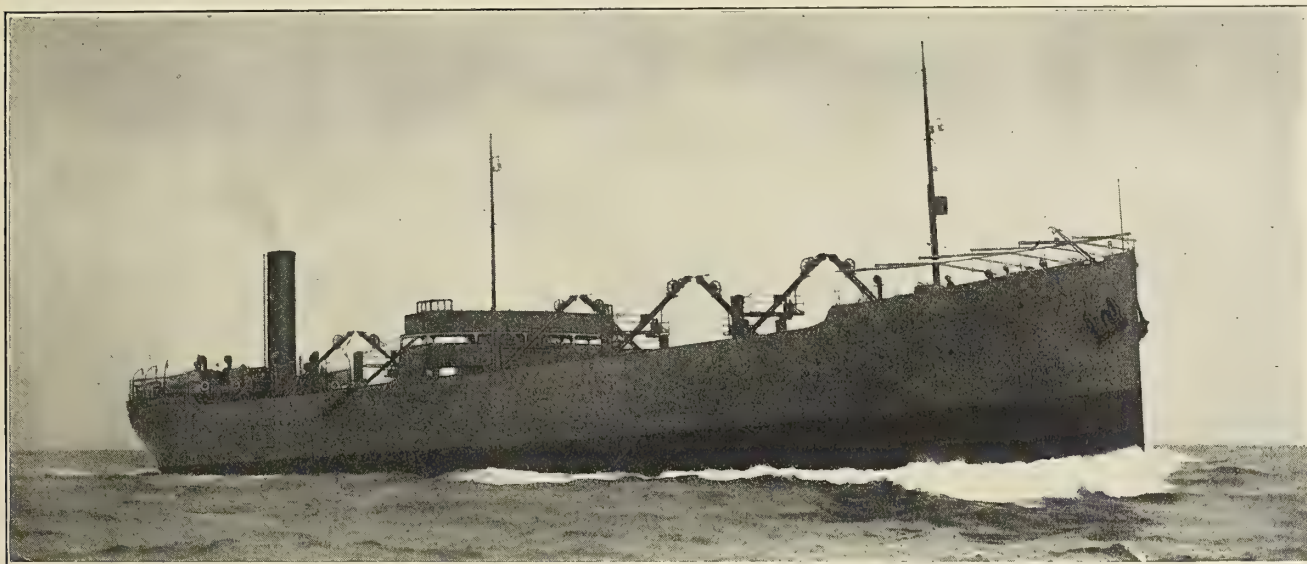


FIG. 4.—NEW TYPE OF ORE CARRYING STEAMSHIP, THE VOLLRATH THAM.

about 2 tons of ore, may be tipped in any position. Fig. 3 gives a view of three of the cranes on one side of the vessel, and of the ore being tipped from two of the skips into lighters at Emden. Experience has proved that, by means of one of these cranes, 40 to 50 tons can be discharged in the course of an hour. We understand that, on the occasion of the first voyage of the *Vollrath Tham*, from Narvik to Philadelphia, Pa., her cargo of 8,200 tons was discharged in 47 working hours by a staff of fifteen men from the ship's crew, and with only five of the cranes working, the consumption of coal, meanwhile, being 10 tons.

In the design of the *Vollrath Tham*, regard was paid, not so much to securing a reduction in the terminal time as the reduction in the cost of labor in discharging at port, and, with a vessel of similar capacity, but built on the ordinary principle, it is claimed that 120 men would have to be engaged 40 hours, and that the coal consumption would amount to about 30 tons.

As the mines from which this Swedish ore is obtained are situated within the Arctic circle, and the stone is sent down to Narvik in a wet state, there is provided under each of the ore pockets in the *Vollrath Tham* a special boiler and system of steam pipes for use in the winter season.

The equipment of the vessel is of the most complete description and includes Welin's patent davits, together with Engelhardt's patent collapsible lifeboats, and also telemotor steering gear. The captain and officers have commodious quarters at

half million tons of ore, possess at this place large storage ground fitted with the most approved appliances for the economical and expeditious handling of large consignments of ore, which are capable of dealing with about a thousand tons of ore per hour, and alongside side which there is a depth of 27 feet at all states of the tide.

The *Vollrath Tham* was built by Messrs. R. & W. Hawthorn, Leslie & Co., Ltd., to the designs, and under the patents of Messrs. Johnson & Welin, of Gothenburg and Stockholm.

The battleship *Louisiana*, built by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., has made a record of 19.08 knots for four consecutive hours, thereby proving herself the fastest battleship in the Atlantic fleet of the United States navy. This record is remarkable, in that the displacement of the vessel was about 1,000 tons greater than on her contractors' trials. Her propellers have recently been changed to turn outboard when going ahead instead of inboard, as formerly, and it is believed that this had much to do with the increase in speed.

The American Society of Naval Engineers held its second annual banquet at Washington on May 7. Among the 200 members and guests present were the Secretary of the Navy, the Speaker of the House of Representatives, a number of officers of high rank, members of Congress and distinguished engineers.

FIRE BOATS DAVID SCANNEL AND DENNIS T. SULLIVAN FOR SAN FRANCISCO HARBOR.

Two new fire boats for the city of San Francisco have recently been completed by the Risdon Iron Works. These boats were built from designs prepared by Marsden Manson, civil engineer, of San Francisco, assisted by T. W. Ranson, consulting mechanical engineer. The principal dimensions of the boats are as follows:

Length over all	129 feet
Length between perpendiculars....	120 feet
Beam molded	26 feet
Depth molded	12 feet 9 inches

The hull is of the single-deck type, with a deck house over the space occupied by the boilers and machinery, with a raised pilot house at the forward end of the deck house. The hull is constructed with a flat plate keel, elliptical stern and straight stem. Forward and aft the hull is cut away, as shown on the sheer plan, and a balanced rudder is fitted. The ship is divided into five compartments by four watertight thwartship bulkheads, and, in addition, oil-tight tanks with a storage of fuel oil are fitted, as shown in the drawings.

HULL CONSTRUCTION

The flat plate keel is 48 inches wide, of 18-pound plate, for 3/5 length amidships reduced to 16 pounds at the ends. The stem is of hammered steel, 6 inches by 1 3/8 inches in a single length, the lower end being scarfed to the flat plate keel. The stern frame is in one piece of cast steel, molded 6 1/2 inches and sided 3 1/2 inches. The rudder post extends to the deck and is secured to the transom. The rudder itself is of the balanced type and is one piece of cast steel. Its weight is carried on deck by means of a cast iron deck plate having a flat bearing filled with white metal.

The center keelson is built of a continuous 14-pound plate, 2 feet 9 inches deep, connected to the keel by double angles, 3 inches by 3 inches by 7 pounds. A flat keelson plate, 24 inches wide and of 16 pounds weight, is fitted to the top of the keelson and connected to it by double angles, also 3 inches by 3 inches by 7 pounds.

The framing of the vessel consists of main frames of 3-inch by 3-inch by 7-pound angles, spaced 21 inches between centers. They extend in one piece from the keel to the deck stringer plate, except in way of the fuel oil tanks. Reverse frames of 2 1/2-inch by 2 1/2-inch by 5-pound angles are fitted on every frame in continuous lengths from the center line to the deck stringer and to 6 inches above the lower side stringer alternately, except in way of the fuel tanks, where they are cut at the oil tank bulkhead. All frames in the engine and boiler rooms are fitted with double reverse angles, extending from the turn of the bilge to the turn of the bilge in the engine room, and from tank bulkhead to tank bulkhead in the boiler room.

Floor plates are fitted to every frame. These are 33 inches deep at the center keelson amidships and increase in depth at the ends and under the engines from frame 15 to frame 20. The floor plates are carried straight on top from bilge to bilge, except in way of the oil tanks, where they are turned up to have a landing on the longitudinal bulkhead not less than 12 inches. The floor plates under the boilers are of 16-pound plate; under the engines and pumps they are of 14-pound, and elsewhere of 12-pound plate. At the watertight bulkheads they are of 14-pound plate and extend 9 inches above the keelson angles. The transom plate is 20 pounds to the square foot.

Bilge stringers extend fore and aft, and consist of double 3-inch by 3-inch by 7-pound angles, fitted back to back and riveted to the reverse frames and to angle clips, except under

the engines, pumps and boilers. Under the boilers they are replaced by 14-pound intercostal plates, worked so as to take the outside holding-down bolts of the boilers, and are secured to the shell plating and floors with 3-inch by 3-inch by 7-pound angle clips, and to a rider plate by 5-inch by 3-inch by 12.8-pound angles. Under the fire pumps 14-pound intercostals are worked, so as to take the outer row of holding-down bolts. These are secured to the shell plating and floors with 3-inch by 3-inch by 7-pound angle clips, and to the rider plate by 5-inch by 3-inch by 12.8-pound angles. A 20-pound rider is worked over the top of the floors extending to the center keelson. Shoes of 5-inch by 3-inch by 12.8-pound angles are worked intercostal below the rider plate in way of the inner row of pump holding-down bolts. Under the engine the floor plates, from frames 15 to 20 inclusive, extend to the under side of the engine seat. Double reverse angles are worked on top of the floors from bilge to bilge. Intercostals of 14-pound plate are worked under the engines in way of the holding-down bolts. The outer intercostal extends to the shell plating and is secured to the floors with 3-inch by 3-inch by 7-pound angle clips, while the inner intercostal extends down to 3 inches above the top of the center keelson and is secured to the floor plates with 3-inch by 3-inch by 7-pound angle clips.

There are two side stringers of double 3-inch by 3-inch by 7-pound angles riveted back to back and to the reverse frames. The lower-side stringers extend from frame 12 to frame 51, and are bracketed to the bulkheads at each end with 12-pound plates. The upper-side stringers extend all fore and aft, and are connected at the ends of the vessel with 12-pound plates forming breast hooks. All keelson bars are carried continuously through the thwartship watertight bulkheads, with watertight collars fitted around them, but they are cut at oil-tight bulkheads with 18-inch by 18-inch by 14-pound brackets on either side.

The main deck beams are 5-inch by 2 1/2-inch by 10-pound bulb angles, fitted on every frame and connected to the frames by 12-pound bracket plates 15 inches deep. The beams at the forward end of the engine room and under the tow bits are 8-inch by 3 1/2-inch by 19.25-pound bulb angles. The lower deck beams forward and aft of the machinery space are 3 1/2-inch by 2 1/2-inch by 8-pound angles, fitted on every frame and connected to the frames by 12-inch by 12-inch by 10-pound bracket plates. The same size beams are used on the upper deck.

The shell plating on the sides and bilges is of 14-pound plate for half-length amidships reduced to 12-pounds at the ends. The sheer strake is of 16-pound plate for half-length amidships, and 14 pounds at the ends. The garboard strake is of 16-pound plate throughout. The bulwark plating is of 10 pounds.

As previously stated, there are four watertight bulkheads. These are built of 10-pound plating above the floors and are braced with both vertical and horizontal stiffeners of 3 1/2-inch by 2 1/2-inch by 8-pound angles. The vertical stiffeners are spaced two feet apart, the lower ends extending well down over the floor plates. The horizontal stiffeners are spaced four feet apart and are bracketed to the shell plating.

The main deck shell plating is of 12-pound plate, and the main deck stringer is of 12-pound plate, 54 inches wide in way of the deck house, tapering to 20 inches at the ends. On top of the deck house and on the lower decks forward and aft of the machinery space the decks are of 10-pound plating.

FUEL OIL TANKS.

Tanks for the storage of fuel oil are located, as shown on the plans. The frames in way of these tanks are cut and a continuous 4-inch by 4-inch by 9.8-pound angle is riveted to the shell plating and the fore and aft bulkheads which

form the sides of the tank. The lower strake of plating is 14 pounds, and the upper strake 12 pounds. The lower strake of the longitudinal bulkhead is flanged outwardly from the tops of the floors at such an angle as to meet the shell plating at an angle of 90 degrees. The floors at the forward end are carried level out to the edge of the boiler foundation, and then bent up so that the depth at the point of meeting with the longitudinal bulkhead is not less than 12 inches. Vertical stiffeners are fitted at each frame, consisting of 3½-inch by 2½-inch by 8-pound angles, carried well down to the frame angles and riveted to bulkhead and floor-plating

PROPELLING MACHINERY.

The main engines are of the direct-acting, inverted cylinder, compound type, having cylinders 13 inches and 28 inches diameter, with a common stroke of 20 inches. All valves are worked by the Stephenson link motion, and a steam reversing engine is fitted at the back of each engine and secured to one of the back columns. The engine cylinders are cast separately, with the steam chests outside or away from the center of the engine. The high-pressure cylinder is fitted with a piston valve and solid cast iron packing rings, arranged to take steam on the inside edges. The upper end of the piston



THE DENNIS T. SULLIVAN, ONE OF SAN FRANCISCO'S NEW FIREBOATS.

brackets on the inside of the bulkhead. Brackets of 14-pound plate are fitted between the ends of floor plates and frames on the side. Each tank is divided into three separate oil tight compartments by intermediate bulkheads. The plates in these bulkheads are 14 pounds at the bottom and 12 pounds above, secured to the shell plating and to the longitudinal bulkhead with 4-inch by 4-inch by 9.8-pound angles. A horizontal stiffener of 8-inch by 3½-inch by 19.25-pound bulb angles is fitted in the tanks and securely bracketed to the 'thwartship bulkheads.

WATER TOWER.

The water tower is a square-latticed column, about 26 feet high above the upper deck. It is 4 feet square at the base, and 2 feet square at the top, and is built of 3½-inch by 3½-inch by 8.5-pound angles at the corners, and cross-latticed with 2-inch bars and gussets. The corner angles are carried down to the main deck and well secured to the 'thwartship bulkheads in the deck house. A platform, about 7 feet in diameter, is fitted about 2 feet below the top of the tower.

valve is larger at the lower part, so as to balance the weight of the working parts of the valve gear. Cast iron liners are fitted in the steam chest.

The low-pressure cylinder is fitted with a double-ported balanced slide valve, the valve seat of which is of close-grained cast iron, secured to the cylinder casting with countersunk Tobin bronze screws. The steam passages and pipes are designed for steam speeds not exceeding the following velocities when the engine is turning at 140 revolutions per minute.

	Feet per minute.
High-pressure ports.....	5,000
Low-pressure ports.....	6,500
Receiver pipe.....	6,000
Condenser pipe.....	6,500

The minimum thickness of the high-pressure cylinder walls is 1¼ inches. The cylinders are fitted together and to their supports by twin bolts driven into reamed holes. The lineal clearance in each cylinder is ⅝ inch divided between the

two ends to the best advantage. Relief valves, with a minimum diameter of 2 inches, with composition valves and seats and adjustable springs, are fitted to each end of each cylinder and to the receiver.

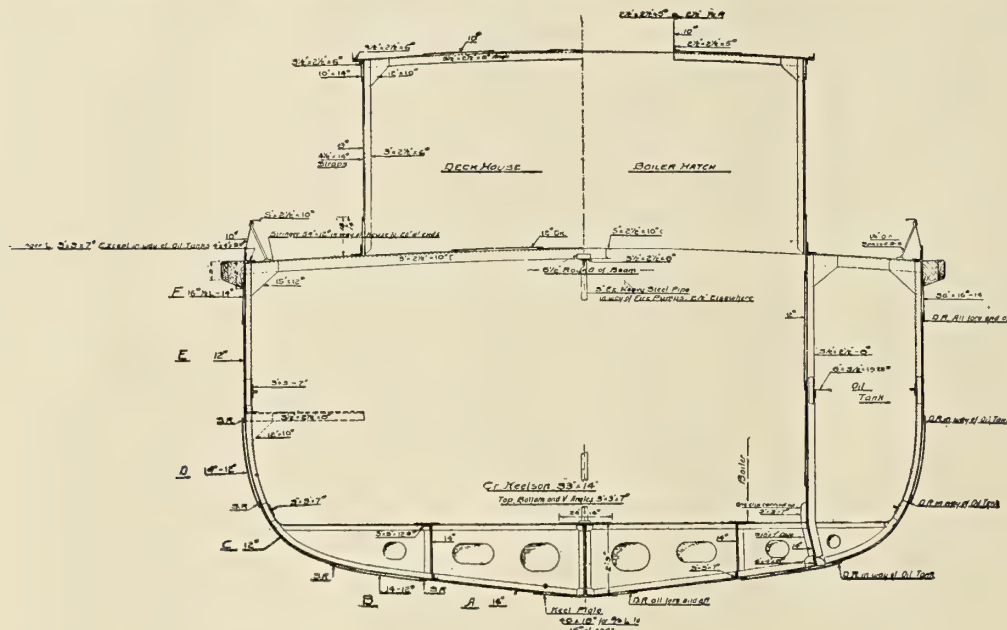
The engine framing consists of two front columns of forged steel 4 inches in diameter, the back columns being of cast iron, with the brackets for the crosshead guides cast upon them.

The pistons are of cast iron, 5 inches deep, fitted with followers. The high-pressure piston is fitted with two cast iron snap rings each $\frac{1}{2}$ inch wide by 1 inch thick. The low-pressure follower is the full depth of the piston and is fitted with two cast iron snap rings, $\frac{3}{4}$ inch square, fitted in the usual manner. The snap rings are arranged so that they

with the high-pressure crank leading. The crank pins are 6 inches in diameter by 8 inches long.

The intermediate and propeller shafting is of the same quality as the crankshaft and the same diameter throughout. The thrust bearing is of the horseshoe type, secured to the engine bed plate and to the engine seat by body-bound steel bolts. The half bearing is 6 inches long. There are three horseshoes of cast iron, bored out for water circulation, lined with white metal and properly grooved for lubrication.

The reversing links are of forged steel of the double-bar type; the distance between centers of eccentric rod pins being 12 inches. The link blocks are of composition, fitted with adjustable gibs, to take up wear. The drag links are round steel bars, $1\frac{1}{4}$ inches in diameter.



MIDSHIP SECTION OF THE NEW SAN FRANCISCO FIREBOATS.

travel $\frac{1}{8}$ inch over the counter bore at the ends of the cylinders. The piston rods are of forged steel, 3 inches in diameter. The crossheads are of forged steel, with pins $3\frac{1}{2}$ inches diameter by 4 inches long, forged solid with the cross-heads. The cross-head block is secured by fitted bolts to a cast iron slide block of the locomotive type completely embracing the guide, lined with white metal, and so designed as to permit of readily taking up the wear. The shoes are $8\frac{1}{2}$ inches wide by 10 inches long. The cross-head guides are of hard, close-grained cast iron, each being a rectangular bar, $3\frac{1}{2}$ inches by 8 inches, cored out for water circulation and finished all over. The connecting rods are of mild steel, forged from a solid bloom without welds. The top end is forked to take the cross-head brasses, and the bottom end has a T-head. The length from the center of the cross-head brasses to the center of the crank pin boxes is 44 inches, and the diameter at the large end is $3\frac{1}{2}$ inches tapering to $2\frac{3}{4}$ inches at the small end. The crank pin boxes are of cast steel, lined with white metal, and the cross-head boxes are of composition not lined.

The engine-bed plate is of the box style of cast iron, riveted to the engine seat. The bearings are of cast iron, lined with white metal, and so arranged as to be readily removed without raising the shaft. There are three journals, each 6 inches bore. The end journals are $8\frac{1}{2}$ inches long, and the center one 11 inches long.

The crank-shaft is 6 inches in diameter, of forged steel, in once piece. The cranks are set at an angle of 90 degrees,

The reversing engine consists of a steam cylinder, 5 inches in diameter and 9 inches stroke, acting on a forged steel arm secured to the rocking shaft.

The main bearings, crank pins and thrust are fitted with water service pipes of brass, and the cross-head guides are fitted with brass or copper pipes for water circulation, the water supply being taken from the circulating pump delivery to the condenser. The main bearings, crank pins, cross-head guides, cross-head journals, thrust and eccentric straps are fitted with lubricating boxes and brass fitting pipes. The oil supply for crank pins, cross-heads and guides is taken from oil boxes secured to the cylinders, and the main steam pipe is fitted with a sight-feed lubricator.

The stern tube bearings consist of a composition sleeve, made in halves and lined with sections of lignum vitæ. The thrust bearing is 24 inches long, and the diameters of the bearings are so arranged that the shafts may be withdrawn outboard whenever the sleeve couplings have been removed. The stern tube stuffing boxes are fitted at the forward ends of the stern tubes and are made of composition bored out for threads with six turns of $\frac{3}{4}$ -inch packing.

The propellers are four-bladed cast iron wheels, each 7 feet 6 inches diameter and 11 feet 6 inches pitch.

There are two watertube boilers of the large, straight-tube type, placed fore and aft with the fire-room between them. The forward boiler contains 2,640 square feet of heating surface and the after boiler about 2,760 square feet of heating surface. Both boilers are built for a working steam pressure

of 200 pounds per square inch. The tubes are all made of seamless steel, 4 inches and 2 inches diameter. Instead of being fitted with grate bars and as usually constructed, these boilers will be fitted with brick furnaces for the use of crude oil as fuel. The oil burners have a capacity for evaporizing 18,000 pounds of water per hour from each boiler when the boilers are in good condition. It is required that the full steam pressure shall be maintained when both engines and both fire-pumping sets are in operation simultaneously.

FIRE PUMPS.

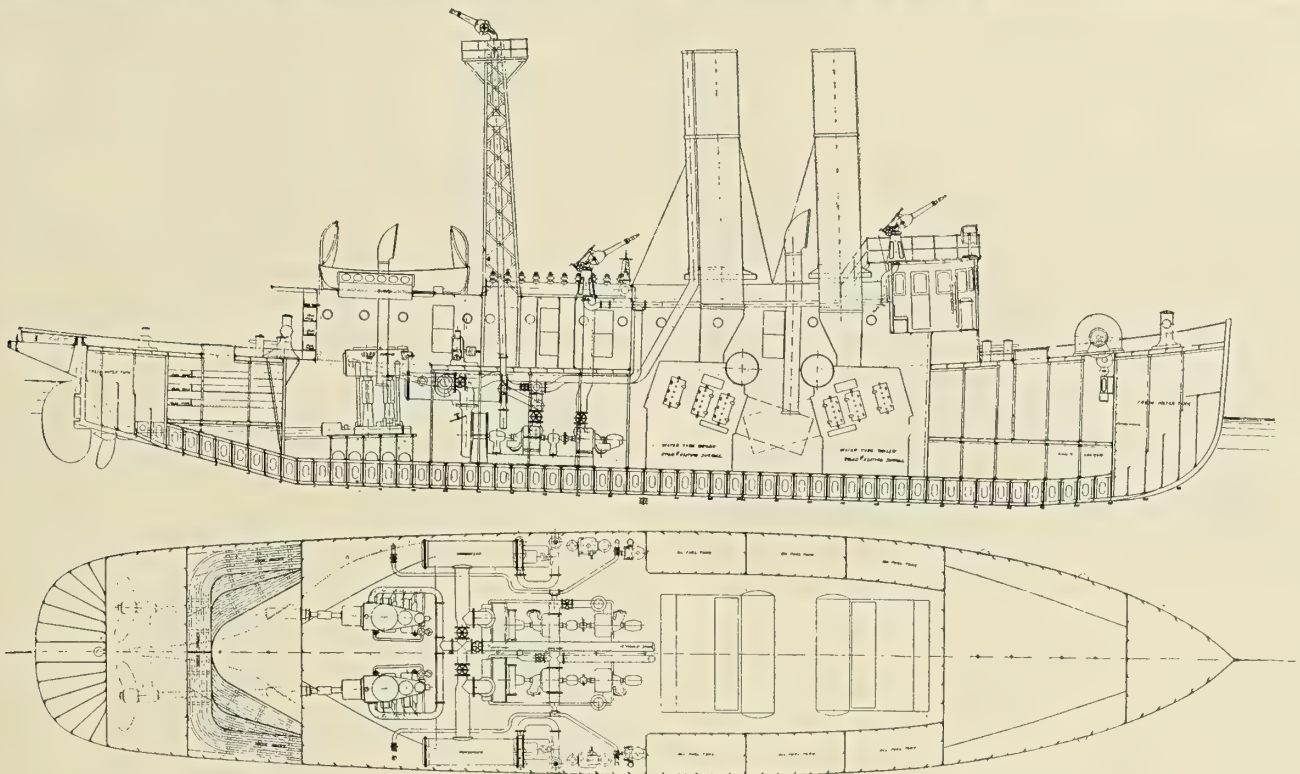
There are two sets of fire pumps in each boat, located amidships between the main engines and the boiler. Each set consists of two pumps of the multi-stage centrifugal type, each capable of delivering not less than 2,000 gallons per minute, against a pressure of 150 pounds per square inch,

riveted to each end for securing the tube sheets and heads. The tube sheets are of rolled Muntz metal, $1\frac{1}{4}$ inches thick. The tube holes are tapped and fitted with screw glands for packing the tubes. The glands are of phosphor bronze, $1\frac{1}{8}$ inches in diameter by $\frac{7}{8}$ inch long, and threaded with 16 threads per inch.

The water chests are of cast iron, and one chest is made with the horizontal division plate so arranged that the circulating water passes twice through the condenser tubes before going overboard. The water chests and tube sheets are secured to the cast iron flanges on the ends of the shell with $\frac{3}{4}$ -inch Tobin bronze bolts and composition nuts.

There are 600 seamless drawn tubes in each condenser, $\frac{7}{8}$ inch in diameter outside, 16 B. W. G. in thickness, 10 feet long and spaced $15/16$ inches centers.

The circulating pump is of the centrifugal type, having a



INBOARD PROFILE AND HOLD PLAN, SHOWING ARRANGEMENT OF MACHINERY.

connected directly to the shaft of and driven by a steam turbine capable of delivering 600 brake-horsepower. The pumps and turbine are mounted on one bed plate. The turbine has a 5-inch steam inlet and an 18-inch exhaust outlet. Both the suction and delivery inlets of each pump are 10 inches.

Two 3-inch stationary monitors are fitted, one on the deck house aft of the boiler casing, and one on top of the pilot house. The end of the play pipe is fitted with a nozzle, 3 inches inside diameter at the smaller end and 4 taps are furnished $2\frac{3}{4}$ -inch, $2\frac{1}{2}$ -inch, $2\frac{1}{4}$ -inch and 2-inch diameter, respectively, for each monitor. There are also two portable monitors fitted with a 2-inch diameter nozzle. The play pipe on the water tower is of the same size as the 3-inch monitor.

AUXILIARIES.

There are two separate surface condensers in the engine room, located at the sides of the vessel and supported under the deck beams. Each condenser is cylindrical, about 34 inches in diameter and 9 feet $9\frac{1}{4}$ inches long between tube sheets, containing about 1,350 square feet of cooling surface measured on the outside of the tubes. The shell is of a single sheet of steel, $\frac{3}{8}$ inch thick, fitted with cast iron flanges

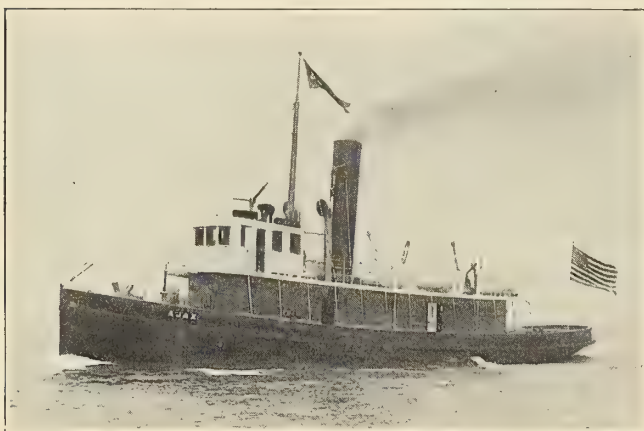
capacity of over 2,000 gallons per minute. It is connected to the shaft of a single cylinder, inverted, direct-acting, open-front type, 6-inch by 7-inch engine. The pump is constructed with cast iron casing, composition runner, bearings and fittings and a Tobin bronze shaft. The inlet and discharge openings are 9 inches in diameter, and the pump is connected to draw from either the sea or the bilge, and discharge through the condenser overboard. The runner is about 30 inches in diameter. The circulating pump engine takes steam from the auxiliary steam line and exhausts to the condenser, heater, or escape pipe. There are two main and auxiliary feed pumps located in the engine room of the vertical, single-piston type, having steam cylinders 10 inches in diameter, water cylinder 7 inches in diameter and a common stroke of 18 inches. The pumps are designed for a working pressure of 200 pounds per square inch. One is located alongside the feed-water tank, to be connected for use as the main-feed pump. This draws from the feed-water tank and discharges to the main-feed pipe. The other pump is connected to draw from the feed-water tank, or sea, and discharge through the main or auxiliary feed line.

The air pumps, two in number, are located in the engine

room. They are of the vertical twin beam pattern, having two steam cylinders, 7.8 inches in diameter, two air cylinders, each 14 inches in diameter, with a common stroke of 10 inches. The donkey pump is of the vertical single-piston type, having a steam cylinder $6\frac{1}{2}$ inches in diameter, a water cylinder $4\frac{1}{4}$ inches in diameter, and a common stroke of 10 inches.

The fuel oil pumps are of the horizontal duplex type, having steam cylinders $4\frac{1}{2}$ inches in diameter, fuel oil cylinders $2\frac{3}{4}$ inches in diameter, and water cylinders 3 inches in diameter, with a common stroke of 4 inches. There are two of these pumps located, one on each side of the fire-room, alongside of the fuel oil tank bulkhead. A cylindrical heater of cast iron or steel, fitted with a seamless copper coil having 15 square feet of heating surface, is fitted to the pump frame. The capacity of the heater is over 35 gallons.

The steam-steering engine is located in the upper engine room, and consists of double engines having cylinders 4 inches in diameter by 5 inches stroke, driving a chain drum through gearing. About 75 revolutions of the engine are required to move the rudder hard over from port to starboard. This en-



PACIFIC COAST TUG AND FIREBOAT.

gine takes steam from the auxiliary steam line and exhausts either into the heater or into the atmosphere.

A steam windlass is located on deck at the bow, which is driven by double engines having cylinders 6 inches in diameter by 6 inches stroke, bolted to the collision bulkhead under the deck. The windlass shaft, which is supported in cast iron standards, properly secured to the deck, is fitted with wild cats and gypsies at each end.

A feed and filter tank of about 500 gallons capacity, constructed of $\frac{1}{4}$ -inch steel plate and angles, is located in the engine room. This is fitted with three division plates from the four compartments, three small and one large. The partitions are so arranged that the feed water entering at the top of the first compartment flows down and under the first partition into the second compartment, thence upward and over the top of the second partition into the third compartment; thence downward and under the third partition into the fourth and largest compartment. A quarter-inch steel plate, perforated with $\frac{1}{4}$ -inch holes, is fitted near the bottom of the third compartment, to act as a screen and prevent any of the filtering material finding its way into the fourth compartment. The first three compartments are filled with filtering material. A feed-water heater of the direct-flow type is located in the engine room on the discharge side of the feed pumps and utilizes the heat of the exhaust from the auxiliaries. The total heating surface is about 150 square feet.

An electric generating set, capable of delivering 10 kilowatts continuously when operated at 450 revolutions per minute under a steam pressure of 90 pounds per square inch and ex-

hausting to the atmosphere, is installed in the upper engine room. The dynamo is a direct-current, 6-pole, compound-wound machine, capable of delivering a current of 91 amperes at a pressure of 110 volts, directly connected to the shaft of a vertical, direct-acting, inverted engine of the enclosed crank-case automatic type, having a single cylinder, $6\frac{1}{2}$ inches in diameter by 5 inches stroke. The machine is designed for an overload of 25 percent in excess of the full load continuously for one hour without movement of the brushes or of injurious sparking, and 50 percent in excess of the full load momentarily without flashing over or injurious sparking. An 18-inch standard searchlight of the Carlisle-Finch make is mounted on the top of the pilot house, as shown in the illustration. This searchlight is 14 inches in diameter, of 5,000 candle power, fitted with glass mirrors and automatic mechanism, and arranged to be controlled from inside the pilot house. It is also fitted with 40-degree diverging lens, which can be controlled from the pilot house. The ship is lighted throughout by electricity.

FIRE TUG AJAX, OF THE SOUTHERN PACIFIC RAILWAY COMPANY.

The *Ajax* is a single-screw steel tug and fire-boat built by the Moran Company, of Seattle, in 1908, for service on San Francisco Bay. Both hull and machinery are of substantial construction throughout, and equal to the highest class of the American Bureau of Shipping.

Her principal dimensions are as follows:

Length between perpendiculars	103 feet 6 inches
Length over all	110 feet 0 inches
Beam, molded	21 feet 0 inches
Depth, molded	12 feet 6 inches
Gross tonnage	175

The hull and deckhouse are built of steel, with a partial steel main deck. The frames are spaced 21-inch centers and are built of $3\frac{1}{2}$ -inch by $2\frac{1}{2}$ -inch by $5/20$ -inch angles, with reverse bars $2\frac{1}{2}$ inches by $2\frac{1}{2}$ inches by $5/20$ inch on every frame carried to the bilge. The garboard and sheer-strakes and the bilge strake for one-half length are of $12\frac{1}{2}$ pound plating. All other steel plating in general varies from 10 pounds amidships to 8 pounds at the ends. The hull is divided into five watertight compartments by four watertight bulkheads. The deck house is of $7\frac{1}{2}$ -inch steel plates, with $12\frac{1}{2}$ -inch coamings, all stiffened by angles placed 21 inches centers.

The vessel has accommodations for a crew of ten on her forward lower deck, and four staterooms for officers on the after lower deck. The galley and mess room are located in the deck house.

The steering gear is of the combined steam and hand type readily changeable from one to the other. Electricity for lighting purposes is furnished by a direct-connected generator. The windlass is of the tow-boat type, fitted with two wild-cats and two gypsies. A large towing bit is located aft of the deck house. Two bollards are fitted on the bow and two on the quarter.

This vessel's propelling machinery consists of a three-cylinder inverted, triple-expansion engine. The high-pressure cylinder is 15 inches in diameter; the intermediate-pressure cylinder 24 inches in diameter, and the low-pressure cylinder 38 inches in diameter.

Steam is furnished by one Babcock & Wilcox marine water-tube boiler having 2,400 square feet of heating surface and equipped for burning oil. The working pressure is 225 pounds per square inch.

The independent auxiliaries consist of a twin-beam air pump (8 inches by 10 inches), a vertical duplex main feed

pump of the Admiralty pattern, 6 inches by 4 inches by 8 inches, a horizontal duplex donkey pump (7½ inches by 5 inches by 6 inches), a 7-inch centrifugal circulating pump driven by a 5-inch by 5-inch vertical engine, and two duplex oil-service pumps. The condenser is of the independent type with a cylindrical steel shell, and has 1,100 square feet of cooling surface. There is also a Reilly evaporator having a capacity of 1,500 gallons of feed water in twenty-four hours.

The propeller is a solid cast iron, four-bladed wheel, 8 feet 5 inches in diameter and 11 feet pitch.

The vessel's fire-fighting equipment consists of one vertical duplex fly-wheel pump of the George F. Blake manufacture, with two steam cylinders, each 17 inches in diameter, two water cylinders each 10 inches in diameter, with a common stroke of 11 inches, and a capacity of 3,000 gallons per minute. There are three monitor nozzles, each with a 3-inch stream, a 6-inch hose manifold located forward, and four hose connections distributed along the deck house.

The fire mains are built for a working pressure of 200 pounds per square inch; the pipes of large diameter being of cast iron, and the smaller ones of extra heavy wrought iron.

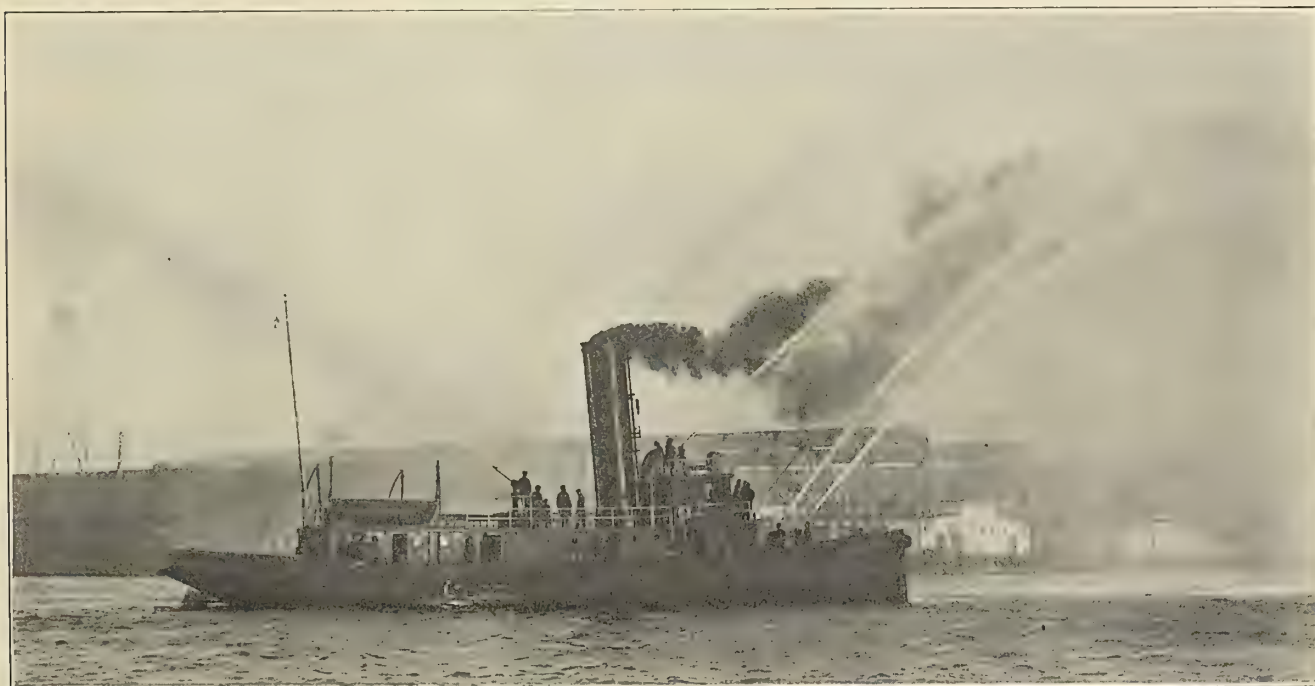
The maximum indicated horsepower of the main engines on

of wood instead of steel. A wooden hull has greater local strength than the thinly plated steel vessel, making it much better adapted to withstand rough treatment at the draw-bridges and wharves and in the ice. Being sheathed with copper over the whole immersed portion of the hull, it also keeps clean indefinitely, while a steel hull would soon foul up in the waters of the harbor. The life of a steel hull would also be very short in service as a Boston fireboat, for the reason that, in touching the first shoal place, the paint on the bottom would be scraped off and the erosive action of the sea water on the mild steel would be rapidly destructive.

The principal dimensions of the hull are as follows:

Length over all.....	113 feet 9 inches
Beam over plank.....	26 feet 0 inches
Depth.....	11 feet ½ inch
Draft, fully loaded.....	9 feet 0 inches

The keel, stem, propeller and rudder posts, rudder, out-board plank, frames, guards and rails are of white oak. The beams, keelsons, ceiling and clamps are of yellow pine, and the deck planks are of Oregon fir. The main deck house is of steel, and the pilot house of wood, the latter being thoroughly



NEW BOSTON FIREBOAT, ENGINE 47, UNDERGOING TEST.

trail was 840 and the corresponding speed 11 knots. The designed speed is 10 knots.

THE NEW BOSTON FIRE BOAT ENGINE 47.

Boston's new fireboat *Engine 47*, is one of the fastest, most powerful and efficient vessels ever built for fire service in America. Her characteristic features were only adopted after a careful consideration of the needs of the water front of the city and a study of the latest types of such vessels built or building for other cities.

In Boston, the number of places demanding protection where the depth of water is limited requires a boat of light draft. The number of drawbridges that have to be passed through, and the presence of heavy ice in the winter season, necessitate a hull of substantial construction to withstand the severe service to which the boat must be subjected. It was with these conditions in mind that it was decided to build the hull

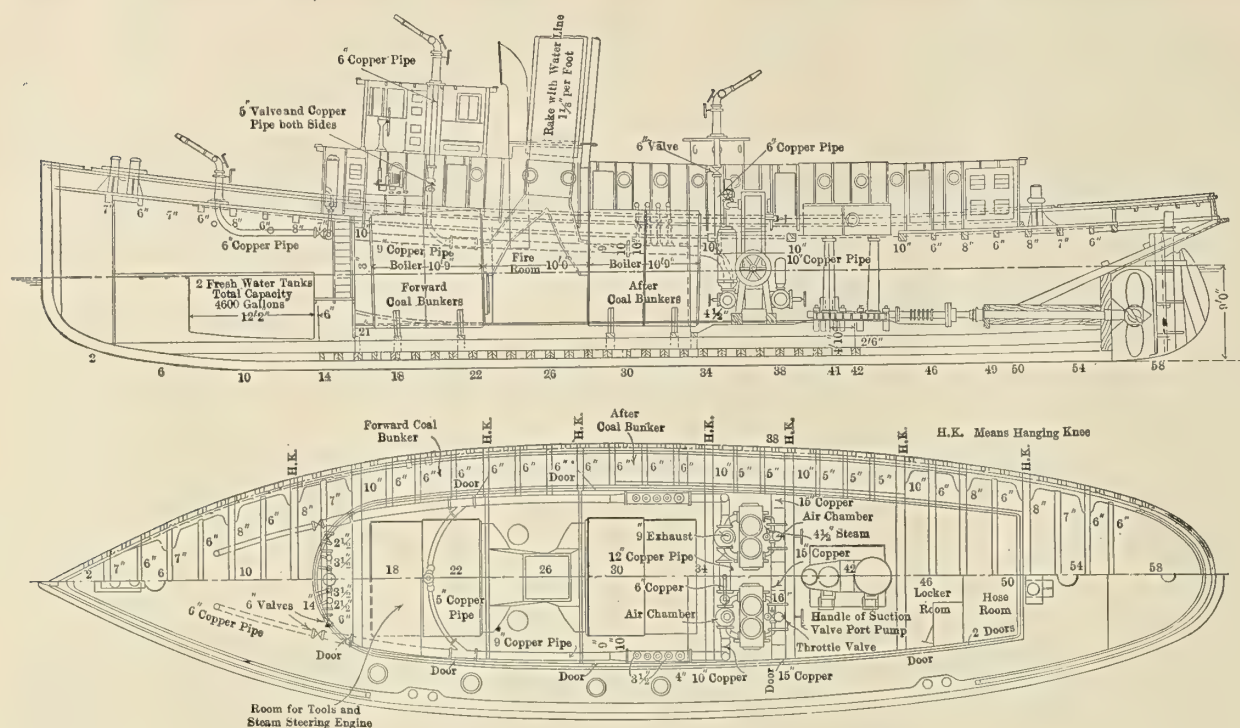
fitted with sprinkling arrangements piped to the fire-service pipe and fitted with valves for regulation. The entire bottom of the boat is sheathed with copper.

As the boat must operate on salt water and be independent of any fresh water supply for feeding boilers, the design of the machinery becomes much more complicated than for cities like Buffalo, Chicago and Detroit, where the feed water is pumped from the lake or river directly into the boilers and no condensing apparatus is necessary.

The new boat is as completely equipped with machinery as an ocean liner, as will be evident from the following condensed description:

The main engines are of the the vertical inverted compound type, high-pressure cylinder 17 inches diameter, low-pressure cylinder 36 inches diameter, the stroke of both being 24 inches. It is fitted with steam reversing gear.

The propeller is four-bladed, of the "built-up" type and is entirely of bronze. It is 8 feet diameter and 11 feet 6 inches pitch.



INBOARD PROFILE AND DECK PLAN OF THE BOSTON FIREBOAT.

The fire pumps, two in number, are of the vertical, tandem compound, duplex flywheel type. The steam cylinders are 12 and 22 inches in diameter, the water cylinders are 10 inches diameter, the stroke of all being 11 inches. They are designed for a combined capacity of 6,000 gallons of water per minute, with a pressure of 175 pounds per square inch at the pumps. In other words, the fire pumps can deliver 25 tons of water per minute at 175 pounds pressure.

One surface condenser is used for condensing all the exhaust steam, so that it may be pumped back into the boilers. There are a vertical twin air pump, a centrifugal circulating pump, two feed pumps, a bilge pump, two boiler circulating pumps and a sanitary pump.

There is an electric generating plant of $7\frac{1}{2}$ kilowatts capacity, sufficient to thoroughly light the boat, and also furnish current for a powerful searchlight.

There is a steam steerer of the Hyde type, operated by a small hand wheel in the pilot house.

The boilers are of the Scotch type, two in number, 11 feet in diameter and 10 feet 9 inches long, built for a working pressure of 140 pounds per square inch. Each has two Morrison suspension furnaces 42 inches least internal diameter. The boilers are connected by breeching with a common double smokestack. Forced draft is provided by the closed ash-pit system, the blower being located in the fire room on the port side and discharging through ducts under the fire room floor into the furnaces below the grates. Dampers are provided for shutting the air off each furnace and for regulation.

There are twelve outlets for $3\frac{1}{2}$ -inch hose for use at fires some distance from the water front. Three thousand feet of hose are carried.

For fires on wharves or vessels, the boat is equipped with five swivel nozzles (or "guns," as they are called by the crew), two on the forward deck, one on the pilot house, one on the main deck house and one at the top of the smokestack. These are all worked by means of hand wheels, so that one man can easily handle one when working at any pressure.

The use of the smokestack as a water tower is unique, no other boat ever having been fitted up in this manner. It is expected to be particularly valuable for reaching fires by

playing over buildings or high piles of lumber that could not be reached in any other way.

The boat was designed by William T. Keough, consulting engineer and naval architect, and has been built under the supervision of Superintendent Eugene M. Byington, of the Boston fire department repair shop.

The contractors for the hull and propelling machinery were the Bertelsen & Peterson Engineering Company, of East Boston, and the fire pumps were built by the George F. Blake Manufacturing Company, of East Cambridge.

At the recent large Lewis Wharf fire, the boat had the first chance to show her real worth. This fire started at night and had gained great headway among a lot of the most inflammable materials, such as resin, cotton, etc., before the alarm was given. The officers of *Engine 47*, with apparently unlimited confidence in the capacity and reliability of the boat, put her right into the slip on the leeward side of the fire and turned all five of the deck guns onto the burning warehouse. In the meantime the older boat (*Engine 44*) had attacked the fire from the other side of the pier. Their combined efforts were of such a high order that the fire, which had threatened to destroy the whole water front, was entirely confined to the pier upon which it started. Officials of the steamship companies who had seen the work of the new boat spoke with unstinted praise of her remarkable performance and the high efficiency of the department.

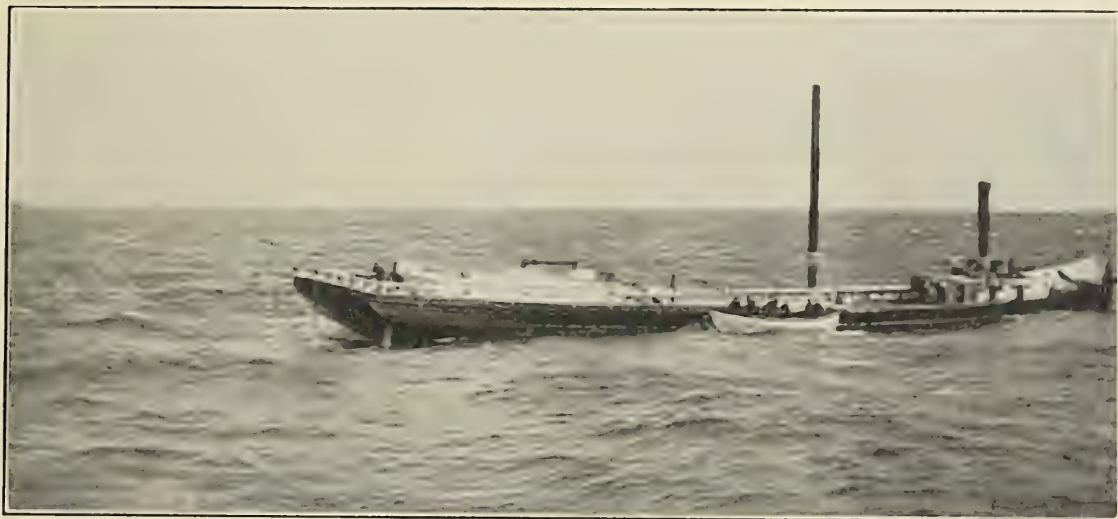
The Rivers and Harbors Bill, which has recently been reported to the United States Congress, carries an appropriation of \$500,000 (£102,500) for experiments to improve the present type of river freight carriers. In connection with the proposed improvement of the upper Mississippi, it is now planned that tests shall be made by the government, with a view to developing a type of freight boat and towboat which will be able to handle commerce in water from 4 to 6 feet deep. If the experiments prove successful, it is expected that private capital will adopt the government's designs, and that there will be a marked increase in traffic on the shallow non-tidal rivers in the country.

THE MENACES OF THE SEA.*

The United States Revenue Cutter Service has been doing great work in removing derelicts and other menaces to navigation from the high seas. In many cases that have occurred during the past winter not only were very dangerous obstructions to commerce removed, but property of considerable value that had been absolutely given up as lost was restored to the

Bay, where she grounded on the rocks entirely out of the path of coasting vessels.

On February 8, 1910, the Dutch steamship *Prins Wilhelm III.* arrived in New York and reported having sighted at sea a derelict consisting of a floating vessel lumber laden, dismantled, waterlogged and abandoned. The news of the derelict was immediately transmitted to the revenue cutter *Seneca* at Tompkinsville, N. Y., and on the following day the *Seneca* left



THE SADIE C. SUMNER WATERLOGGED AT SEA.



THE SUSIE M. PLUMMER, DERELICT OFF CAPE RUSSELL, VANCOUVER ISLAND.



THE FOUR-MASTED SCHOONER ASBURY FOUNTAIN.

owners. Three striking examples of the efficiency of this service have lately been recorded.

On January 25 the revenue cutter *Snohomish*, stationed at Neah Bay, Wash., discovered a derelict, which proved to be the *Susie M. Plummer*, off Cape Russell, near the northwest end of Vancouver Island. For two days during a southeast gale the *Snohomish* stood by the derelict, and finally on the third day, the sea and wind having moderated, the wreck was boarded and a line made fast to it. An attempt was made to tow the derelict into Puget Sound, where it was thought a portion of the cargo of lumber might be saved, but, on account of the heavy sea and the weight of the tow, the hawsers on the cutter could not stand the strain, and the derelict was eventually allowed to drift ashore in the vicinity of San Josef

for the reported position of the wreck. Owing to unfavorable weather conditions, the derelict was not located until the morning of the 11th, when it was found somewhat to the southward and eastward of the originally reported location. Investigation proved that the derelict was the three-masted schooner *Sadie C. Sumner*, of Thomaston, Maine.; that the hold of the vessel contained a valuable cargo of cypress lumber, the deck load having been washed overboard, as was everything else above the main deck, and that the ground tackle and hull were in good condition, although the rudder stock had been carried away, rendering the rudder useless.

The *Seneca* took the derelict in tow and immediately started for the Virginia capes, but at night a northeast gale sprang up, making progress, which under the most favorable weather conditions was slow and arduous, entirely impossible, so the *Seneca* hove to, leading the tow lines from her forward chocks

* By courtesy of The Army and Navy Register.

and utilizing the wreck as a sea anchor. During the night, however, both tow lines parted, and the derelict was again adrift on the sea until after the gale abated on the 13th, when the *Seneca* recovered her prize, and, taking it in tow, headed in again for Chesapeake Bay.

After this, on two different occasions the wreck, being heavy and cumbersome on account of her waterlogged condition, parted the lines of the revenue cutter, but finally on the night of the 15th the *Seneca* stood into Hampton Roads and anchored the derelict under Sewall Point.

On March 3, 1910, while standing up the coast bound for Chesapeake Bay, the steamship *Jamestown*, of the Clyde Line, collided with the four-masted schooner *Asbury Fountain*, of New York, and damaged her so badly that her crew were forced to immediately abandon her. The crew of the *Fountain* were taken off their sinking vessel by the *Jamestown* and transported to Norfolk, but the ill-fated schooner was left adrift on the high seas, a floating derelict in the path of all vessels bound in or out of Chesapeake Bay.

The news of the accident and the existence of this huge derelict was immediately transmitted to the Revenue Cutter Service at Washington, and on the afternoon of that day the revenue cutter *Onondaga*, under wireless orders from the Department, left Norfolk in search of this menace to navigation. The *Fountain* was found on the morning of March 5 in a position fifteen miles south-southwest from *Winter Quarter Shoal* lightship, and preparations were immediately made for towing the derelict to port. The bow had been stove in and the schooner appeared to be anchored to the bottom by wreckage from her foremast and bowsprit, and on account of her injuries it was necessary to tow the wreck stern foremost.

In this manner the tow proceeded toward Hampton Roads, but, on account of the mass of wreckage over the bow and the difficulty experienced in steering the derelict, little progress was made. On the afternoon of the 5th the *Mohawk* arrived on the scene, having been sent out from New York to search for the derelict, and having picked up the wireless calls of the *Onondaga* for assistance. The *Mohawk* ran a hawser from her bow to the mainmast of the schooner, and by skillful maneuvering was able to successfully steer the *Fountain* and materially increased the speed of the tow. To facilitate the handling of the tow, a mine was exploded under the bow of the derelict, clearing away a quantity of the wreckage which had impeded the efforts of the cutters.

On the following day, March 6, the two cutters passed slowly in through the entrance of Chesapeake Bay and beached the big derelict on the flats near the mouth of the Elizabeth River, when it was identified and taken possession of by the owners.

THE BATTLESHIP OF THE FUTURE.*

BY REAR ADMIRAL R. H. S. BACON, C. V. O., D. S. O.

In these days the battleship has developed merely into a vessel for fighting other battleships, and it shuns as far as possible encounters with most other classes of vessels, and it is particularly vulnerable to torpedo attack. The problem of building a ship which cannot be sunk by the explosion of a torpedo, or which will not be incapacitated by torpedo attack, has heretofore baffled all solution.

The modern battleship is solely a gun platform. The gun is at the present moment the main weapon in deciding naval actions, therefore progress in battleship design has continually been in the direction of increased offensive gun power and defensive armor protection against gun power. So much has the power and accuracy of modern guns been improved that the

accuracy of the gun to-day at 12,000 yards is considerably greater than the accuracy of the gun of thirty years ago at 2,000 yards. At the present moment the development of the gun shows no reason for abating, and there is every reason to believe that, if required, the power of the gun can, within the next few years, be considerably increased. Whether or not such an increase is desirable depends somewhat upon another factor in battleship design, namely: its defensive armor.

In the battleship, speed is sacrificed to armor protection, but there is no doubt that the gun of the present day, with armor-piercing projectiles, at a range of about 6,000 yards can penetrate any armor which can be practically mounted in a ship, and guns can be built which can penetrate this armor at ranges outside which it would be practically impossible to bring a fleet action to a decisive conclusion. It is, therefore, perfectly hopeless to think of attempting to supply armor which would be impenetrable to guns which may be constructed in the reasonable future.

As far as increasing the size of guns is concerned, there is no immediate necessity for increasing the power of the gun in order to perforate the present-day armor, but the armor-piercing projectile is not the most efficient shell for effecting general damage on a ship, and penetration of armor is not the sole object of gun fire. The chief damage will probably be done by heavy bursting charges and, other things being equal, the larger the gun the larger the projectile, and the better the result from this point of view. An increase in the size of guns, however, can only be made at the expense of either the number of guns carried, the armor protection or a reduction in speed. Closely related to this question is the question of increase in displacement. This is a question which must be settled largely from the point of view of expense, expediency, efficiency and general utility. The main arguments against increase in size are the enormous cost of each ship and, therefore, the large loss in case of sinking, and the inadequacy of present harbor facilities and docks. There seems to be no doubt that the larger the ship the more likely she is to survive the blow of a torpedo. Surviving, however, is not the sole point. Damage by a torpedo will temporarily incapacitate a ship however large she may be, and therefore a bigger money value of fighting appliance will be temporarily incapacitated by a single torpedo attack in the case of the large ship than in the case of the smaller, but, whereas the damage may be repaired in the large ship, the smaller ship may sink, and the loss thus become permanent. The question of cost is likely to be one of the deciding features in the increased size of warships.

The abolition of the secondary armament in a modern battleship has tended to improve the accuracy of hitting of the heavier guns, and has also caused a saving in weight which can be utilized for other purposes. If it were possible to install 6-inch guns in a ship without either restricting the fire of the heavier guns or unnecessarily increasing her displacement, and if it were thoroughly understood that they were only there to be used in thick weather, there might be some advantage in installing them. The difficulty, however, of such an installation is very great. If placed below the tier of heavy guns their position comes very close to the water. If placed on a level with the heavier guns they are bound to reduce the arc of fire of the 12-inch guns, and if placed above them they involve considerable top weight, since they are useless unless properly protected with armor. Up to the present, those responsible for the construction of British ships appear to take the point of view that the advantage of the intermediate caliber is not worth the extra displacement. Considering 6-inch guns solely from the point of view of defense against torpedo-boat attack, there is good excuse for considering this, since anti-torpedo guns require no armor protection. If, however, 6-inch guns should be used for anti-torpedo boat guns, instead of 4-inch, they would set a low limit on the

* From a paper read before the Institution of Naval Architects, London, March, 1910.

thickness of armor belt, since it would obviously be foolish to reduce this to an amount which would allow these small guns to effect penetration at battle ranges, and, therefore, to allow the ship to be open to vital attack by small guns.

There is no difficulty in handling and maneuvering the large battleships in company with smaller vessels.

Recent improvements in torpedoes make this weapon an extremely powerful factor in modern naval warfare, and, as seems likely, if the range of the torpedo can be brought up to 6,000 yards, it will be a still more important factor.

The third possibility of saving weight is a reduction in speed. The recent increase in speed in battleships has been severely attacked from a technical point of view, although it is greatly appreciated from a strategical point of view. Judging from past experience, however, it is improbable that the designed speed of modern ships will be reduced. Due to the improvements in the torpedo, there will in time be introduced a class of tactics more analogous to a single ship than fleet actions. It is in such a class of tactics that speed will become a valuable factor, and it is highly probable that the speed of battleships will increase up to that of cruisers.

All the considerations of offense and defense point to increase in size of battleships as modern gun construction ad-

MECHANICAL GEARING FOR MARINE TURBINES.

The Application of the Marine Steam Turbine and Mechanical Gearing to Merchant Ships.*

BY HON. C. A. PARSONS, C. B., F. R. S., D. SC.

The steam turbine has not as yet been applied to vessels of slow, normal speed on account of the high initial cost and inferior economy in steam; further, no promising scheme has as yet been evolved having for its object the modification of the turbine or propeller, so as to reduce the efficient speed of revolution of the former and increase that of the latter for vessels of 12 knots sea speed and under; and the only approach of meeting these conditions (if we except gearing propositions) has been in the combination system, where the turbine plays a secondary part in the equipment by utilizing the lower portion of the expansion of the steam between the low-pressure cylinder of the reciprocating engine and the condenser. This system was fully explained in the paper by Mr. Walker and myself at the meeting of this institution in March, 1908.

The complete and most satisfactory solution for slow-speed vessels would appear to be by means of gearing, provided the losses in transmission, first cost, and cost of maintenance are

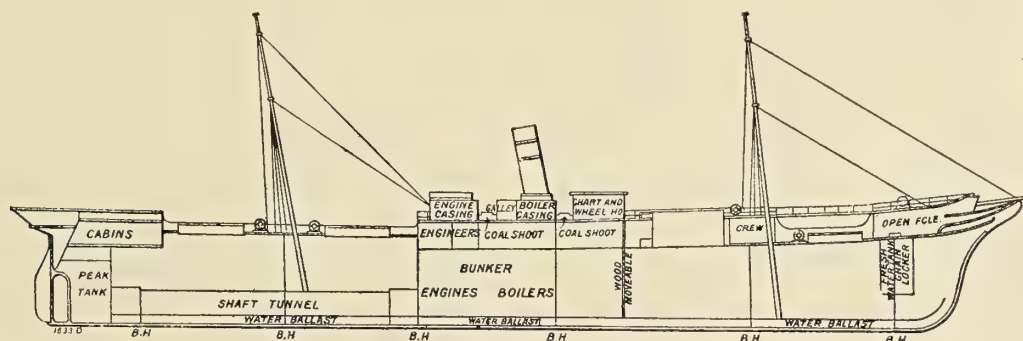


FIG. 1.

vances. But since the modern battleship no longer holds the supreme position which in the old days made the battleship the sole ultimate arbiter of sea power, it is improbable that as the torpedo improves, battleships, unable to defend themselves against any form of torpedo craft, will be built merely to fight battleships. The functions of the large cruiser will, therefore, be assumed by the battleship, high speed will become more and more necessary, and armor protection will be less accentuated than at present. The link between the ocean-going destroyer and the battleship will become closer, and we may reasonably expect that the monsters of the future will always be accompanied by torpedo craft of high sea-going speed as defensive and offensive satellites.

The battleship as now known will probably develop from a single ship into a battle unit consisting of a large armored cruiser with attendant torpedo craft. Line of battle as we now know it will be radically modified, and the fleet action of the future will in the course of time develop into an aggregation of duels between opposing units. The tactics of such units open up a vista of most exhilarating speculation and will afford to the naval officer of the future a scope for his tactical skill never dreamed of by us or our predecessors.

The whole future is pregnant with radical obliteration of our present opinions as regards tactics, but we may confidently prophesy that size of ships and power of gun will increase and increase until war, the great arbitrator among theories, will reform or reconstitute our opinions regarding naval armaments.

not too great. Many forms of gearing—mechanical, electrical and hydraulic—have been proposed or applied on a small scale.

I believe the first application of helical spur gearing to drive a propeller was made by the Parsons Marine Steam Turbine Company, Ltd., in 1897. The turbine was of 10 horsepower, geared to two wheels, each wheel driving a propeller shaft. The revolutions of the propellers were 1,400 per minute, and the ratio of the gear 14 to 1. The turbine was of the Parsons type, with a reversing turbine on the same shaft, incorporated in the same casing. The gear was single helical. The turbine took part of the thrust of the propeller, the remaining thrust being taken on the thrust-bearing in the gear casing. The air, circulating, and oil pumps were driven by worm gearing off one of the screw shafts. The launch was 22 feet over all, and attained a speed of 9 miles an hour. This launch was built to the order of Mr. F. B. Atkinson, for his yacht *Charmian*. The launch was sent to the Turbinia Works in 1904, and the turbine was generally overhauled and cleaned. The gear was found to be in perfect order, and did not require any repair. Helical and double-helical gear of fine pitch, suited to high speeds of rotation was, I believe, first introduced by Dr. De Laval, of Stockholm, and has been extensively used in connection with this turbine for many years with entire success and at a moderate cost of maintenance. I have had several experimental sets constructed. One of these

* From a paper read before the Institution of Naval Architects, London, March, 1910.

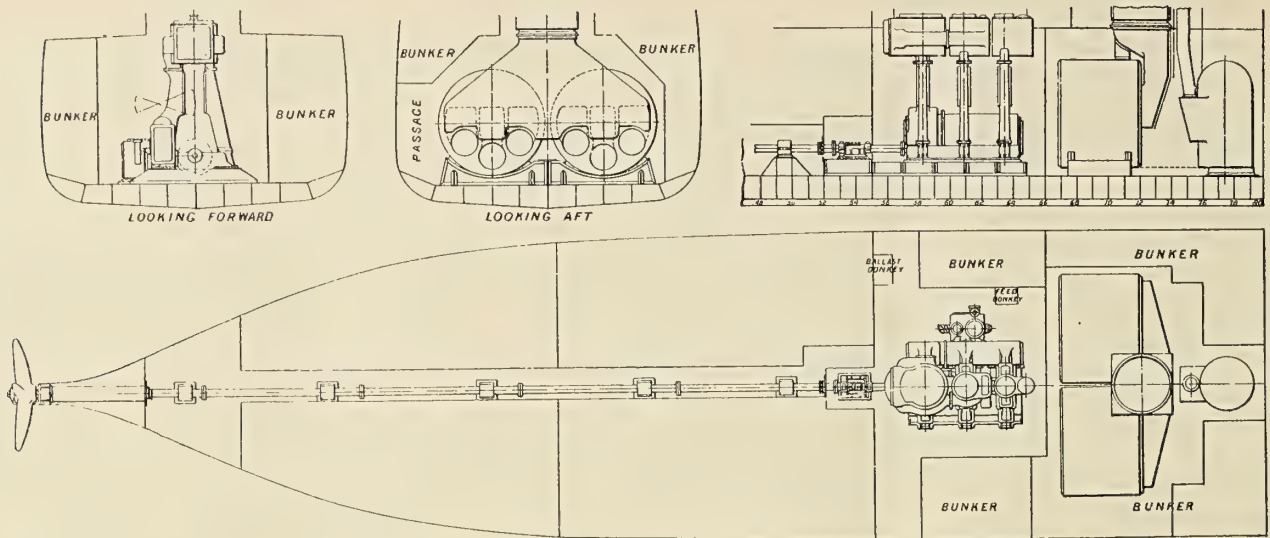


FIG. 2.—GENERAL ARRANGEMENT OF RECIPROCATING ENGINES AND BOILERS IN S. S. VESPASIAN.

was a double-helical gear of the De Laval type, made in 1897, gearing from 9,600 revolutions of the turbine to 4,800 of the dynamo, transmitting 300 horsepower. The efficiency was estimated by the method of heat loss to be above 98 percent. This gear was cut in an ordinary universal milling machine without any special precaution as to accuracy, and I was much impressed (in spite of the obvious irregularity of the teeth) by finding how well it ran, except that it made a considerable noise.

Gears that have been recently cut by the Power Plant Company and by special machinery run with very little noise. A recent experimental set of gearing cut by Messrs. D. Brown, of Huddersfield, for a speed reduction from 2,000 to 400 revolutions, transmitting 300 horsepower, according to a Heenan-Froude water-braked dynamo meter, has a total loss in the gear case, including friction of gear and bearings, of 1½ percent.

In the summer of last year the directors of the Turbinia Works Company decided to test turbines mechanically geared to the screw-shaft of an existing typical slow-speed vessel, and a cargo vessel, named the *Vespasian*, was purchased for

this purpose. The *Vespasian* was built in 1887 by Messrs. Short Brothers, of Sunderland. Her dimensions are: Length on load-waterline, 275 feet; breadth, molded, 38 feet 9 inches; depth, molded, 21 feet 2 inches; mean loaded draft, 19 feet 8 inches; and displacement, 4,350 tons.

The vessel had originally an ordinary triple-expansion surface condensing engine, by Mr. G. Clark, of Sunderland, with cylinders 22¼ inches, 35 inches and 59 inches in diameter by 42-inch stroke. The air, circulating, feed and bilge pumps were driven from the intermediate-pressure crosshead with the usual arrangement of levers and links. The condenser was cast with the back columns of the main engine, and had a cooling surface of 1,770 square feet. The boilers—two in number—are 13 feet in diameter by 10 feet 6 inches long, with a total heating surface of 3,430 square feet, and grate area of 98 square feet, working under a pressure of 150 pounds, with natural draft. The propeller is of cast iron, and has four blades, having a diameter of 14 feet, a pitch of 16.35 feet and an expanded area of 70 square feet.

With a view to obtaining comparative data between the turbine installation and the reciprocating engine, it was decided to

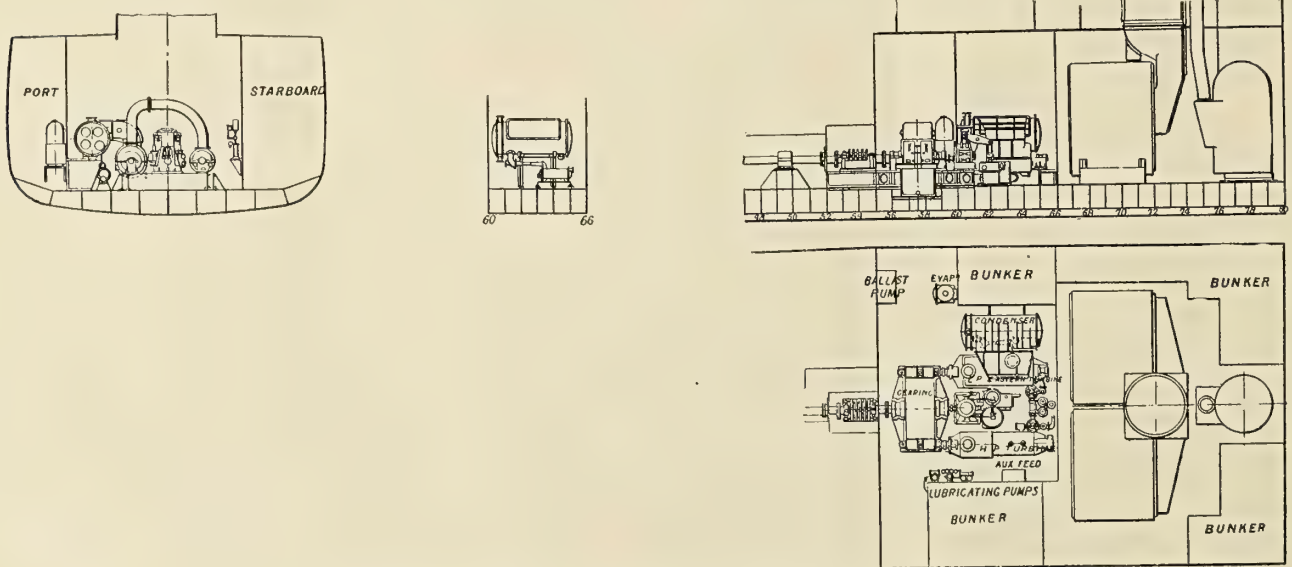


FIG. 3.—GENERAL ARRANGEMENT OF TURBINES AND GEARING IN S. S. VESPASIAN.

run trials with the vessel with her reciprocating engine previous to its removal, and the installing of the turbines and gearing.

Fig. 1 shows a profile of the vessel, and Fig. 2 a general arrangement of the reciprocating engine and boilers.

Before proceeding on the voyage upon which data regarding the performance of the reciprocating engine were taken, the propelling machinery was completely dismantled and overhauled. The high-pressure piston valve chamber was rebored and new valve rings fitted; slide valves were replanned and faced up; bearings were renewed, and other repairs carried out wherever necessary to bring the machinery into an efficient condition and first-class working order. To obtain reliable

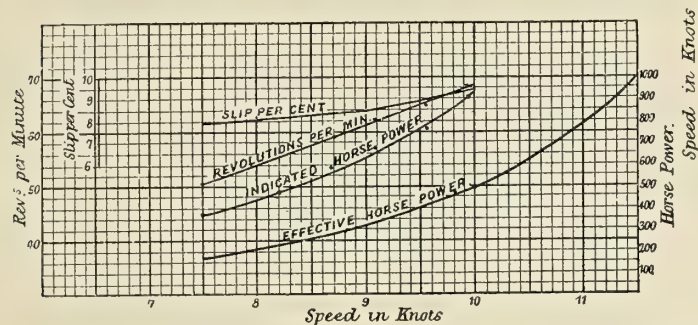


FIG. 4.

measurements of water consumption, two tanks were fitted, each of 400 gallons capacity, with suitable change cocks and connections for the air pump to discharge through these measuring tanks.

It was necessary, for the purpose of obtaining data under service conditions, that the vessel should be run at her loaded condition. Arrangements were consequently made with a firm of shipbrokers to take a cargo of coal from the Tyne to Malta, and on June 26, last year, the *Vespasian* left the Tyne, in a loaded condition, with a special recording staff on board, and on this voyage careful measurements of coal and water consumption were made.

The data and results of a progressive trial carried out on the Whitley Bay mile are given in Table 1, from which, together with the data taken on the voyage referred to, the curves in Figs. 4 to 7 and 9 have been plotted.

Fig. 4 (full lines) shows the results of the progressive trial to a basis of speed of vessel. The effective horsepower shown

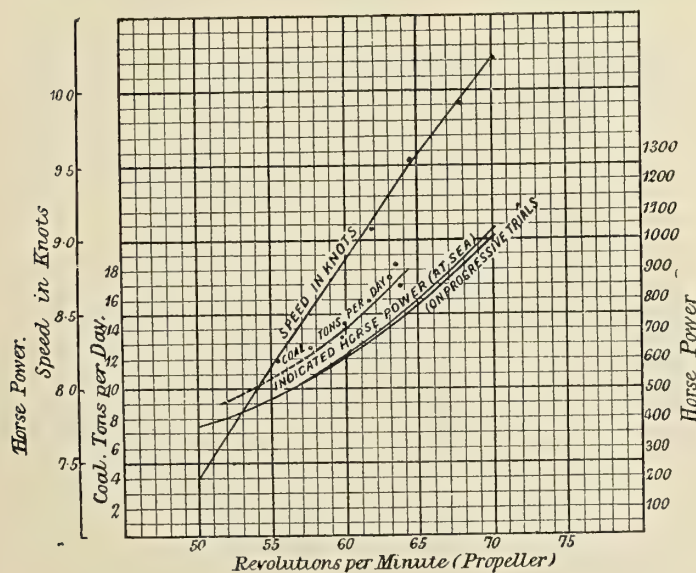


FIG. 5.

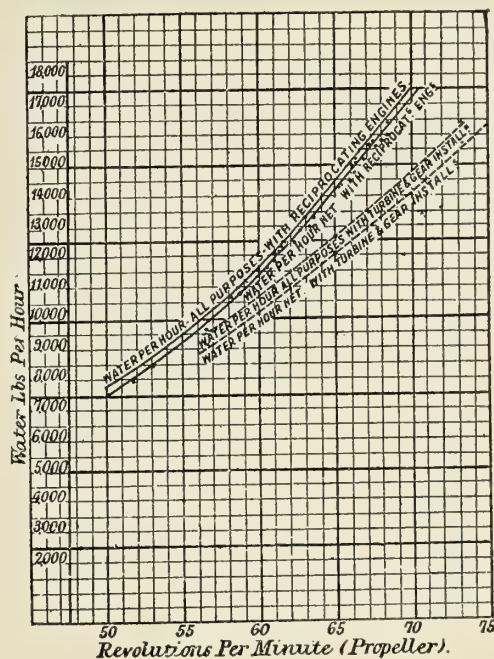


FIG. 6.

on this diagram is calculated from the resistance as obtained from a model experiment of the vessel to a scale of $\frac{3}{8}$ inch to the foot.

Fig. 5 (full lines) shows the results as obtained on the voyage, plotted to a basis of revolution. For the sake of comparison, the indicated horsepower taken on the progressive trial is also shown, together with the speed corresponding to revolutions taken on the measured mile.

Fig. 6 (full lines) shows the water consumption per hour for main engines only and for all purposes to a basis of revolutions. The difference between these two curves represents the

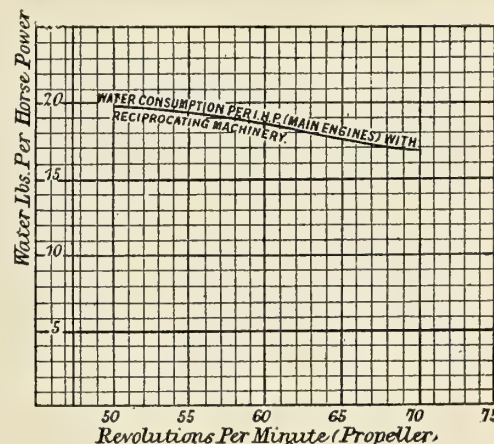


FIG. 7.

consumption of steam of steering engine, the exhaust of which was led to a separate measuring tank.

Fig. 7 shows the water per indicated horsepower also plotted to a basis of revolutions.

Fig. 9 shows the propulsive coefficient plotted to a basis of speed.

On the completion of the voyage, the vessel returned to the Turbinia Works, where her reciprocating engine was taken out, engine seats remodeled and preparation made for the reception of the turbines and gearing.

Fig. 3 shows the general arrangement of the turbine machinery and gearing.

The only alteration made to the vessel was in the type of

propelling engines; the boilers, propeller, shafting and thrust blocks remained the same as for the reciprocating engine.

The propelling machinery consists of two turbines in "series," viz.: one high-pressure and one low-pressure, the high-pressure turbine being placed on the starboard side of the vessel and the low-pressure on the port side. At the after end of each of the turbines a driving pinion is connected with a flexible coupling between the pinion shaft and the turbine, the

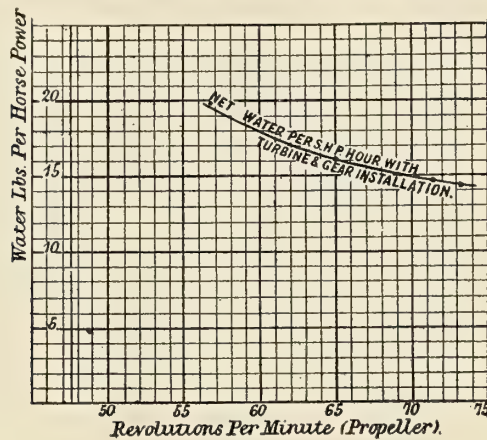


FIG. 8.

pinion on each side of the vessel being geared into a wheel, which is coupled to the propeller shaft.

A reversing turbine is incorporated in the exhaust casing of the low-pressure turbine. The air, circulating, feed and bilge-pumps are of the usual design for tramp steamers, and are driven by means of a crank and connecting-rod coupled to the forward end of the gear-wheel shaft. The turbine and pinion-shaft bearings are under forced lubrication, as in ordinary turbine practice. The teeth of the pinions and of the gear-wheel are lubricated by means of a "spray" pipe extending the full width of the face of the wheel. Independent oil-pumps are fitted for supplying oil to the bearings and gear-

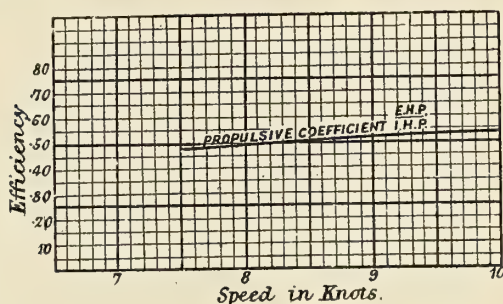


FIG. 9.

wheel. With a view to the possibility of experimenting with different lubricants for the gear-wheel, the oiling system for the bearings is separate from that of the gear-wheel.

The high-pressure turbine is 3 feet maximum diameter by 13 feet over-all length, and the low-pressure 3 feet 10 inches in diameter by 12 feet 6 inches length. The turbines are similar in design to a land turbine, being balanced for steam thrust only, the propeller thrust being taken up by the ordinary thrust-block of the horse-shoe type, which is fitted aft of the gear-wheel. A new condenser, together with a vacuum augmentor, is fitted with the turbine installation. The cooling surface of the condenser is 1,165 square feet.

The gear-wheel is of cast iron, with two forged steel rims shrunk on. The diameter of the wheel is 8 feet 3½ inches pitch circle, having 398 teeth—double helical—with a circular pitch of 0.7854 inch. The total width of the face of the

wheel is 24 inches; the inclination of teeth 20 degrees to the axis.

The pinion shafts are of chrome nickel steel, 5 inches in diameter pitch circle, with 20 teeth 0.7854 circular pitch. The ratio of gear is 19.9 to 1.

On the completion of the erection, on board, of the turbine-gearing installation at the end of February of this year, the vessel was loaded to the same draft and displacement as that under which the trials referred to in Table I. were run. As already mentioned, the propeller has not been touched or altered in any way. In the short interval since the completion of her alterations, the vessel has been out to sea on four occasions.

Table II. gives the data and results of a run made off the Tyne on 11th of this month:

TABLE 1.—S. S. VESPASIAN. PROGRESSIVE TRIAL ON HARTLEY MILE, WITH RECIPROCATING ENGINES.

	S.	N.	Mean.	S.	N.	Mean.
Direction of run.....	S.	N.	Mean.	S.	N.	Mean.
Speed.....	7.438	7.563	7.50	8.531	7.860	8.195
Revolutions per minute.....	49.9	51.27	50.58	55.1	55.5	55.3
Boiler pressure in pounds.....	126	130	128	138	129	133.5
H. P. receiver pressure.....	73	72	72.5	82	84	83
I. P. receiver pressure.....	17.5	17.25	17.37	20.5	22	21.25
L. P. receiver pressure.....	-4.75	-6	-5.37	-4.5	-4.75	-4.62
L. P. exhaust pressure..... in.	27	27	27	27	27	27
Vacuum..... in.	28.25	28.37	28.31	28.5	28.5	28.5
Barometer..... in.	29.96					
Mean H. P. pressure.....	30.75	30.35	30.55	34.25	34.85	34.55
Mean I. P. pressure.....	13.8	13.85	13.82	14.8	14.6	14.70
Mean L. P. pressure.....	3.91	4.125	4.01	4.8	4.87	4.83
I. H. P., H. P.....	124	126	125	152.5	156.5	154.5
I. H. P., I. P.....	139	143.5	141.2	164.5	164	164.2
I. H. P., L. P.....	113	122	117.5	153	156.5	154.7
I. H. P., total.....	376	391.5	383.7	470	477	473.5
Temp. circ. inlet.....	55.5					
Temp. circ. disc.....	76	81	78.5	87	87	87
Temp. hotwell.....	73	71	72	81	85	83
Direction of run.....	S.	N.	Mean.	S.	N.	Mean.
Speed.....	9.278	8.090	8.684	11.009	9.399	10.204
Revolutions per minute.....	58.4	59.3	58.85	70	70.1	70.05
Boiler pressure in pounds.....	135	143	139	152	149	150.5
H. P. receiver pressure.....	95	95	95	128.5	127.5	128
I. P. receiver pressure.....	26	26	26	44	45	44.5
L. P. receiver pressure.....	-3.37	-2.75	-3.06	3	3.62	3.31
L. P. exhaust pressure..... in.	26.8	26.8	26.8	25.2	25.2	25.2
Vacuum..... in.	28.25	28.25	28.25	26.5	26.5	26.5
Barometer..... in.						
Mean H. P. pressure.....	37.3	38.15	37.72	47.6	47.95	47.77
Mean I. P. pressure.....	17.25	17.45	17.35	24.8	24.65	24.72
Mean L. P. pressure.....	5.61	5.91	5.76	8.86	9.51	9.18
I. H. P., H. P.....	176	183	179.5	269	272	270.5
I. H. P., I. P.....	204	209	206.5	351	348	349.5
I. H. P., L. P.....	189.5	203	196.2	359	387	373
I. H. P., total.....	569.5	595	582.2	979	1007	993
Temp. circ. inlet.....						
Temp. circ. disc.....	91	90	90.5	106	107	106.5
Temp. hotwell.....	91	92	91.5	118	119	118.5
Direction of run.....	S.	N.	Mean.	S.	N.	Mean.
Speed.....	10.778	9.068	9.923	10.315	8.759	9.537
Revolutions per minute.....	67.4	68.27	67.83	64.9	64.36	64.63
Boiler pressure in pounds.....	142.5	130	136.2	143	132	137.5
H. P. receiver pressure.....	129.5	115	117.75	113	107	110
I. P. receiver pressure.....	40	42	41	36.5	35.5	36
L. P. receiver pressure.....	1.5	2.75	2.12	-75	-1	-87.5
L. P. exhaust pressure..... in.	25.75	25.5	25.62	26.2	26	26.1
Vacuum..... in.	27.25	26.87	27.06	27.67	27.37	27.52
Barometer..... in.						
Mean H. P. pressure.....	44.12	43	43.56	41.85	42.25	42.05
Mean I. P. pressure.....	23.2	24.67	23.93	21.7	22	21.85
Mean L. P. pressure.....	8.42	8.8	8.61	7.18	6.96	7.07
I. H. P., H. P.....	241	237.5	239.2	220	220	220
I. H. P., I. P.....	316	340.5	328.2	284.5	286	285.2
I. H. P., L. P.....	328.5	344	336.2	269.5	259	264.2
I. H. P., total.....	885.5	922	903.7	774	765	769.5
Temp. circ. inlet.....						
Temp. circ. disc.....	101	104	102.5	97	98	97.5
Temp. hotwell.....	112	116	114	98	101	99.5
Direction of run.....	S.	N.	Mean.	S.	N.	Mean.
Speed.....	9.809	8.824	9.316	8.824	9.326	9.075
Revolutions per minute.....	62	62.1	62.05	62.1	61.3	61.7
Boiler pressure in pounds.....	128	128	128	128	120	124
H. P. receiver pressure.....	101	102	101.5	102	100	101
I. P. receiver pressure.....	31	30.5	30.75	30.5	32	31.25
L. P. receiver pressure.....	-1.5	-1.5	-1.5	-1.5	-2.5	-2
L. P. exhaust pressure..... in.	26.25	26.25	26.25	26.25	26.25	26.25
Vacuum..... in.	27.5	27.75	27.62	27.75	27.67	27.71
Barometer..... in.						
Mean H. P. pressure.....	39.3	40.5	39.9	40.5	40.5	40.5
Mean I. P. pressure.....	20.25	19.7	19.97	19.7	20.55	20.12
Mean L. P. pressure.....	6.32	6.5	6.41	6.5	5.83	6.16
I. H. P., H. P.....	197.5	203.5	200.5	203.5	201	202.2
I. H. P., I. P.....	253.5	247	250.2	247	254.5	250.7
I. H. P., L. P.....	227	233.5	230.2	233.5	206.5	220
I. H. P., total.....	678	684	681	684	662	673
Temp. circ. inlet.....						
Temp. circ. disc.....	94.5	94	94.2	94	94	94
Temp. hotwell.....	94	93	93.5	93	94	93.5

Draft taken at Whitley Bay. Draft, forward, 19 ft. 1 in.; draft, aft, 20 ft. 3 in.; draft, mean, 19 ft. 8 in. Dimensions, molded, 275 ft. by 38.75 ft. by 21.16 ft. Displacement 4350 tons; coefficient, 0.754. Propeller, solid cast iron, four blades; diameter, 14 ft.; pitch, 16.35 ft.; expanded area, 10,100 sq. in. Measured mile at Hartley. High-pressure cylinder—diameter 22 1/2 in.; mean cut-off, 71 percent; intermediate cylinder—diameter, 35 in.; mean cut-off, 63 percent; low-pressure cylinder—diameter, 59 in.; mean cut-off, 64 percent; stroke, 42 in.

The water consumptions per hour at the several rates of revolutions have been plotted in Fig. 6, shown in full lines for the reciprocating engines, and in dotted lines for the turbine-gear engines. It will be noted that under normal full-speed steaming conditions an increase of about 1 knot is obtained with the same coal consumption. Fig. 8 shows the water consumption per shaft horsepower for the geared turbines.

TABLE II.—TRIALS WITH TUBINES AND GEARING.

Speeds in knots.....	8.4	9.56	10.5	10.66
Revolutions per minute.....	56.5	65	71.3	73.3
Boiler pressure.....lb.	145	144	140	145
Initial pressure, high-pressure turbine.....lb.	60	86	110	121
Initial pressure, low-pressure turbine.....lb.	15.2	12.5	7.1	5.5
Vacuum.....in.	28.8	28.8	28.7	28.5
Barometer.....in.	29.9			
Shaft horsepower.....	456	740	980	1095
Water consumption per hour, main engines.....lb.	9070	12,000	14,480	15,670
Water consumption per hour, all purposes.....lb.	9670	12,620	15,120	16,370
Water consumption per shaft horsepower per hour, main engines.....lb.	19.8	16.2	14.8	14.3

It will be noted that the observed mean speeds on the measured mile, given in Table II., correspond to the speeds obtained with the reciprocating engines at the same revolutions in Table I., thus eliminating any necessity for allowances, the weather conditions in the two cases being very similar. It may be mentioned that the turbines and gearing have given no trouble, and have worked satisfactorily with very little noise or vibration throughout the trials. Further, there is no appreciable wear on the teeth or bearings. It is proposed to put the vessel into commission and run extended trials.

THE MARINE STEAM ENGINE INDICATOR—XI.*

BY LIEUT. CHARLES S. ROOT, U. S. R. C. S.

PRELIMINARY TESTS.

The indicator and necessary engine attachment being provided, the preliminary tests, which should be made before taking diagrams, will now be considered. From the scrap on board select any piece of metal of sufficient size for the purpose and drill and tap it to suit the thread on the straightway cocks (Fig. 44, January, 1910), which should be provided with every indicator intended for marine use. If a suitable piece of metal cannot be found any threaded pipe fitting will do provided the thread is of the proper size. Screw the indicator cock into the fitting and secure the fitting in a bench vise, so that the axis of the cock will stand vertical. The indicator may now be attached to the cock in the usual manner. This is a convenient way to hold the instrument while making some of the tests to be described. The indicator itself should never be clamped in a vise.

Having secured the instrument in a handy location, fit a stiff spring to the piston and cover and examine for lost motion by trying to move the pencil in various directions in a vertical plane. When the piston-rod guide forms an essential part of the parallel motion this should be examined with particular care. The mechanism should be gone over until there is no unrestrained movement at the pencil. All lost motion having been taken up in the pencil mechanism, the swivel head, which carries the entire mechanism, should be tried for slackness where it bears on the frame of the instrument. The moving parts should now be tested for friction as follows: Remove the spring and piston, raise the

pencil to its highest working position, and let go. It should fall instantly to its lowest position. Attach the piston—without the spring—and work the pencil lever slowly and carefully up and down, feeling all the while for any suspicion of a “catch” or binding. If any sticking is detected its cause must be ascertained and removed before going further. A slight roughness in the cylinder or on the surface of the piston may sometimes be corrected by polishing with the finger end covered with rotten stone and oil, or with any of the fine red polishing pastes made of crocus. With the piston still in place on the rod, raise the pencil to its full working height and close the cock on the steam inlet. The pencil should remain at the top of its stroke or sink very slowly. On opening the cock with the piston at any point the pencil should drop instantly to its lowest designed position. It is not at all essential that the piston should be absolutely tight, but it should be tight enough to prevent the pencil falling quickly when the steam inlet is closed. If the instrument will not pass these friction tests, after carefully taking up all lost motion, it should be sent to the maker for overhauling, and if the instrument is a new one, it should be rejected and another required.

In order that the pencil may bear on the card with constant pressure at all points it is necessary that the drum be truly round and accurately centered. It is also essential that the drum axis be parallel with the plane in which the pencil moves. These conditions are tested for as follows: Remove the piston spring, but leave the piston attached to the rod. Adjust the stop on the swivel head, so that “day light” is just visible between the pencil point and the drum surface. Using a lead pencil or soft-wood stick from below, push the piston slowly upwards through its full travel, sighting all the time between the drum and pencil point. If the distance changes in the slightest degree, either the drum axis or pencil mechanism is out of line. The drum should next be rotated by pulling on the cord. If there is any change in the space during this operation the drum is either “out of round” or improperly centered. These tests should be repeated with the drum in various positions and the pencil at different heights. If the drum is not true, remove it from the base ring, clean the seating and replace. If it cannot be made to run true after cleaning and reseating it should be returned to the factory for correction. If used with the drum in bad condition the pencil will drag in spots and throw the diagram out.

The vertical and horizontal lines drawn by the instrument must be straight and “square” with each other. Put a paper card on the drum; adjust the stop so that the pencil point will just touch the paper. Push the piston up—as before described—drawing a vertical line. Fit a piston spring to the instrument and draw a fine horizontal line by pulling on the cord. If the lines thus drawn are not straight, or if they do not make an angle of 90 degrees, either the pencil motion is incorrect or the drum may have a slight vertical movement on its stem. The squareness of the lines may be tested in several ways, but the most accurate and convenient method is probably as follows: In Fig. 82 let $x x$ and $y y$ be the test lines drawn by the indicator, and let O denote the point of intersection. With O as a center and a radius equal (roughly) to three-fourths of $O y$, describe the arc ABC . With the same radius and with B as a center describe the arc DOY . B should be so located on ABC that it will cut $x x$ at an angle of about 45 degrees. With an accurate straight edge pass a line through D and B , and produce it to cut $y y$, as shown. If the test lines are square, $y y$, DBY and the arc DOY will cross each other at the same point.¹

¹ By Geometry: “An inscribed angle is measured by one-half its intercepted arc,” and in consequence “an angle inscribed in a semi-circle is a right angle.”

If the vertical line crosses at any other point—as at *Z*—the test lines are out. This checking should be done with sharp pencils and compass points and an accurate straight edge. The ordinary triangles or set squares used by draftsmen should not be used—unless they have been tested and are known to be correct—for the reason that those made of wood, celluloid and even of hard rubber change their shape when a few months old. Metal squares are, of course, not open to this objection.

The indicator should now be tested for correct proportional

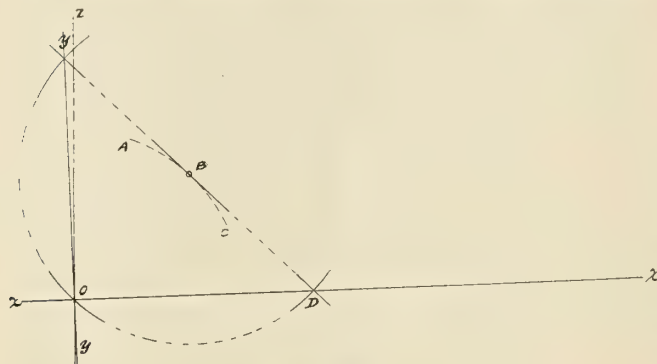


FIG. 82.

movement of the pencil relative to the piston. The simplest way to make this test is to move the piston by means of a uniform fine pitch screw. Attach a 10 or 20-pound spring to the indicator piston in the usual way, the instrument being secured in a fitting clamped in a bench vise, as above described. On the bottom of the piston, piston rod or piston rod nut of almost every indicator a lathe center will be found. File one end of a small brass rod to a point. Seat the point in the latter center, the rod projecting downward through the cock towards the sliding bar of the front jaw of the vise. If the reader has an inside micrometer at hand, the brass rod should be of the same diameter as the extension bar shown at the right in Fig. 83. The rod should be cut to a convenient length and clamped in the chuck above the micrometer head and the lower end of the micrometer seated in a center punch mark on the sliding bar of the vise or on a metal plate secured to the vise. Care should be taken to have the ends of the micrometer so placed that there will be no lateral movement, and the extension bar should be watched while under compression, in order that the



FIG. 83.

test may be stopped in case the rod should spring or bend. If an inside micrometer is not at hand one of the ordinary outside variety can be adapted to the job by casting a white metal block and fitting it to span the "anvil," as shown at *A* in Fig. 84. The brass extension rod *B* is screwed into the block. The frame of the micrometer must, of course, be rigidly secured to the metal piece holding the indicator, so that the whole rig is in line. If a micrometer is not to be had, one can be improvised with threaded rods and nuts, care being taken to provide a proper index so that the screw can be turned exactly one revolution at a time.

The gear being in readiness, put a card on the drum, turn the micrometer upward until it has a firm bearing on the piston; note the position of the index on the screw; apply the indicator pencil to the card; rotate the drum by pulling the cord, and draw a long, fine, horizontal line. Remove the pencil; let the drum recoil; turn the screw upward exactly one revolution and proceed as before. Repeat the operation until the pencil has

risen a little over two inches above the original line. If the pencil is raised higher there is danger of injuring the piston spring. This test must be conducted with great care. The movement of the pencil is usually more than four times that of the piston, and a very small error in the screw movement will show an apparently large pencil error.

The calibration being completed, remove the diagram and test, as shown in Fig. 85. The diagram shows thirteen spaces.

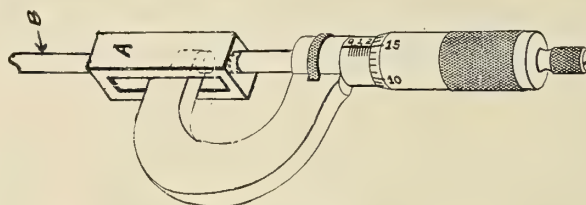


FIG. 84.

Count off the same number on any equally divided scale, the spaces being of such length that their sum will be a little greater than the distance between the top and bottom lines. Place the scale across the lines so that the extreme divisions—in this case 0 and 65—will fall on the top and bottom lines. If the test lines are equally spaced they will coincide with the main

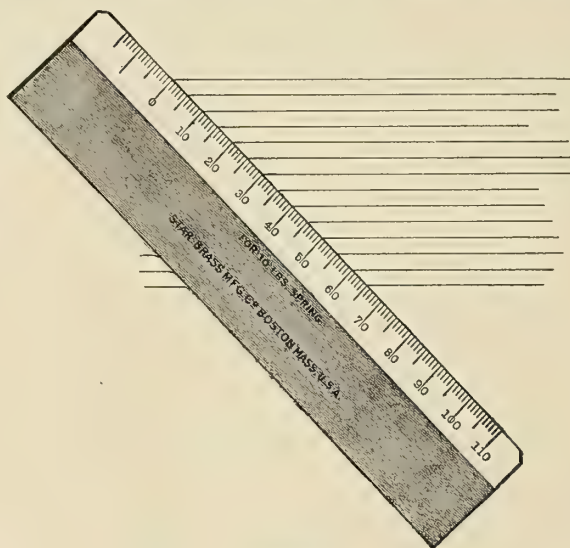


FIG. 85.

divisions of the scale,² as at 0, 5, 10, 15.....65. This method of testing equally spaced lines should be remembered, as it is frequently made use of in indicator work.

(To be continued.)

Increased Economy in Coal and Oil Consumption by United States Naval Vessels.

In a statement prepared by the United States Navy Department, it is shown that a total of 350,296 tons of coal were used by the vessels in the navy during the first half of the fiscal year 1910. From the reports received by the Navy Department and the data compiled therefrom it appears that at a given speed per nautical mile run on the basis of an average for all the ships in commission, a decrease of about 12 percent in coal and 8 percent in oil is recorded. While this saving

² For by geometry we know that: "If a series of parallels, cutting two straight lines, intercept equal distances on one of these lines, they also intercept equal distances on the other." In this case one line being the edge of the diagonal rule and the other line a vertical line square with the parallels.

is partly due to less cruising service it should be noted that the saving of coal on that account was counterbalanced largely by the increased average speed at which the ships in general were cruising. The total amount of coal saved during the first half of the year amounted to about 56,000 tons.

The reasons for this increased economy are to be found not only in the improved design and type of machinery now used in American warships, as compared with older types, but also to the materially increased efficiency of the personnel in the operation of the machinery and in firing.

Some of the records which are particularly noticeable are the following: The battleship *Missouri* used 25 percent less coal per nautical mile run when under way during this period and 35 percent less while in port. With the *Kansas*, the saving was 12 percent, and with the *Rhode Island* 11 percent. The record for the *Missouri* is all the more remarkable when it is considered that this battleship has been in commission for seven years, and during that period has never been completely overhauled at a navy yard. Furthermore, on recent speed trials this vessel showed approximately a knot greater speed than on her official trials, when she was new and when a large bonus was to be paid for every additional half knot above contract speed. This increased speed was obtained on a greater displacement than that on which the builders' trials were carried out.

Still better results from an economical standpoint are anticipated in the coal consumption of ships where superheated steam is being used, and in oil where the steam turbine is used in place of the reciprocating engine.

LAUNCH OF THE BRITISH BATTLESHIP COLOSSUS.

The *Colossus*, the ninth British battleship of the Dreadnought type, was launched in April from the yards of Scott's Shipbuilding & Engineering Company, Greenock. This is the first battleship of the Dreadnought type launched on the Clyde, although the battle cruisers *Indomitable* and *Inflexible* were built there, the former at Fairfield and the latter at Clydebank. The Fairfield Company were also the contractors for the propelling machinery of the *Bellerophon*, and the Scott's Company supplied the propelling machinery for the *St. Vincent*, but the last battleship built in a Clyde yard for the Royal navy was the *Agamemnon*, built by William Beardmore & Company.

The *Agamemnon's* immediate predecessors on the Clyde were the *Hindustan*, built at Clydebank, and the *Commonwealth*, built at Fairfield, both launched in 1903. Seven years have elapsed since then, but the development of the battleship has been notable in the short time. That progress can be followed by a table:

	Displacement.	I. H. P.	Designed Speed Knots.
<i>Hindustan</i>	16,350	18,000	18.5
<i>Commonwealth</i> ..	16,300	18,000	18.5
<i>Agamemnon</i> ...	16,500	16,750	18
<i>Colossus</i>	20,250	25,000	21

The *Colossus* is 510 feet long and 86 feet beam. Her displacement is 20,250 tons, and her turbine engines, designed for 25,000 indicated horsepower, are expected to give her a speed of 21 knots.

The advance that has been made in respect of gun power may be shown by the statement that whereas the *Hindustan* and the *Commonwealth* have each only four 12-inch and four 9.2-inch guns, the *Colossus* will have ten 12-inch guns. The *Agamemnon* has fourteen guns of large caliber, but only four are 12-inch guns, the remainder being 9.2-inch guns of 50 calibers. All the nine Dreadnoughts are ten-gun ships. In the *Dreadnought*, the *Bellerophon*, the *Temeraire* and the *Superb* the

length of the gun is 45 calibers, and in the *Vanguard*, the *Collingwood*, the *St. Vincent*, the *Neptune* and the *Colossus* it is 50 calibers.

The growth in size of the type of vessel is shown below:

	Length. Feet.	Beam. Feet.	Draft. Feet.	Displacement. Tons.
<i>Dreadnought</i>	490	82	25½	17,900
<i>Superb</i>	490	82	27	18,600
<i>Temeraire</i>	490	82	27	18,600
<i>Bellerophon</i>	490	82	27	18,600
<i>Vanguard</i>	500	84	27	19,250
<i>Collingwood</i>	500	84	27	19,250
<i>St. Vincent</i>	500	84	27	19,250
<i>Neptune</i>	510	86	..	20,250
<i>Colossus</i>	510	86	..	20,250

In the *Colossus* the 'midship guns are placed *en echelon*. The whole ten are available for use on either broadside. On the battleships the diagonally-placed guns fire across the deck, under a kind of boat deck. This structure accommodates the 4.7-inch guns of the anti-torpedo armament, which are not easy to place. The 4.7-inch gun is preserved for anti-torpedo armaments because of great rapidity of fire.

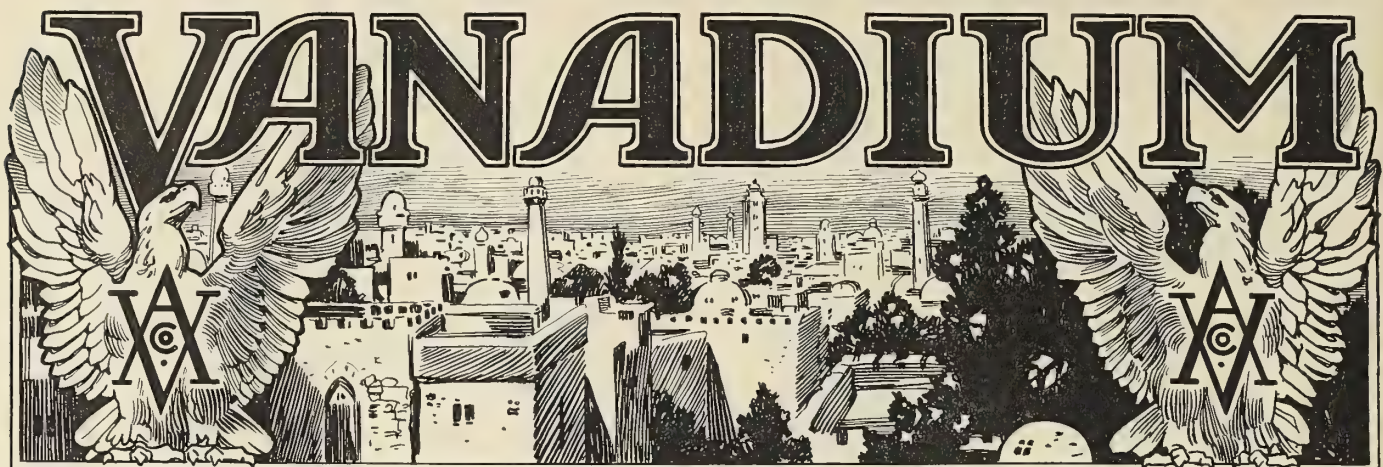
The *Colossus* is the first large variation of the *Dreadnought*. In broadside-fire design she presents a great improvement, in the diagonal placing of the two 'midship guns and the placing of the ten guns in five turrets on the middle line, as in the *Conqueror*, the *Monarch* and the *Thunderer*. In the latest twelve-gun German ships the arrangement is similar to that on the Brazilian *Minas Geraes* and *Sao Paulo*, except that the wing turrets are *en echelon*. The new French ships have adopted the *Minas Geraes* arrangement, and the American ships have their gun turrets on the middle line. The Americans were the pioneers of that disposition. The Japanese adhere to mixed armaments, on the experiences gained at Tsushima.

H. M. S. *Hercules*, sister ship to the *Colossus*, the contract for which was placed with Palmer's Shipbuilding & Iron Company, Jarrow-on-Tyne, is to be launched on May 10, and the *Warrego* (the third of the Australian torpedo boat destroyers) is to be completed in July. The *Warrego* is being built by the Fairfield Shipbuilding & Engineering Company, Clyde, and will be shipped in sections to Australia, and rebuilt in one of the Commonwealth dockyards by Australian workmen. The *Colossus* is to be ready for trials in nine months. Only nine months elapsed between the laying of the keel and the launch.

In this connection we may add that the two cruiser battleships, of the *Indefatigable* type, which are to be built for the governments of Australia and New Zealand, respectively, have been placed by the Admiralty. One is to be built by the Fairfield Shipbuilding & Engineering Company, Ltd., Clyde, and the other by Messrs. John Brown & Company, Ltd., Clydebank. They will each cost about £1,800,000, and they have been placed by the Admiralty by arrangement with the governments of Australia and New Zealand. They form parts of the fleet units which are to be provided by the two colonial governments, but they will be integral parts of the British navy, subject to the orders and regulations applying to the other ships of the fleet. They are additional to the five armored ships of this year's British naval programme, and will be completed in 1912.

Including the orders for the two colonial cruiser-battleships, there are now on hand on the Clyde twenty-nine British warships—two Dreadnought battleships, two Dreadnought cruisers, five protected cruisers and twenty torpedo boat destroyers.

This is the largest number of vessels, and the largest tonnage, that have ever been under construction on the river at one time for the British navy. In addition, the district expects a share of the naval programme of the current year.



A Damascus Sword

will bend to a right angle under your foot, and return exactly to its alignment; you can cut bones and tempered steel rods with it and it won't show nicks; its edge is so fine that it will sever a piece of gossamer floating in the air.

⁴For two thousand years men have tried to imitate the steel of the original Damascus blades, but neither skill nor materials brought success.

Recently chemists found Vanadium in the finest Swedish irons and steels. They added Vanadium to ordinary steel and thus made Extraordinary Steel. To-day Vanadium is a commercial product, and in the past few years it has revolutionized the possibilities of high grade steels. It increases all the physical properties wonderfully, improves cast iron, bronze and brass, gives strength with ductility, prevents crystallization, imparts five-fold wearing qualities, and makes "anti-fatigue" steel.

With intelligent heat treatment Vanadium Steels surpass the best steels of old Damascus. Vanadium is added in the crucible, in the open hearth furnace, the electric furnace, or the foundry ladle, in small quantities, can be controlled accurately, is used in homeopathic doses, costs little, requires no special apparatus, and gives results previously unknown in Metallurgy.

For all high duty parts—gears, iron cylinders, bushings, cutting tools, dies, chains, pistons, forgings, guns and deck plate, Vanadium must be used for the maximum of strength, service and safety. Descriptive booklets free.

The American Vanadium Company

318 FRICK BUILDING
PITTSBURGH PA.

DOUBLE THE LIFE OF YOUR BEARINGS

Victor Vanadium Bronze has increased the wearing power and life of bearings to such a wonderful extent that it is recognized as the peer of all other composition bearing metals.

Remember that Victor Vanadium Bronze is at least Ten per cent. lighter in actual weight than any other bronze casting of the same dimensions. This very important factor in combination with its acknowledged uniformity, strength, ductility and wearing qualities, render its adoption in all marine bearings and bushings an economic necessity.

COMPARATIVE BEARING TESTS OF VICTOR VANADIUM BRONZE AND OTHER COMPOSITION METALS

No. OF BEARINGS	R. P. M.	LOAD IN LBS.	TIME		
			M.	S.	
1	400	3000	2	15	VICTOR VANADIUM BRONZE
2	400	2000	1	30	VICTOR VANADIUM BRONZE
3	400	2000	1	45	VICTOR VANADIUM BRONZE
4	400	2000	1	00	REGULAR BEARING METAL
5	400	2000	1	15	HIGH GRADE BEARING METAL
1	400	3000	2	15	VICTOR VANADIUM BRONZE
2	400	2000	1	30	VICTOR VANADIUM BRONZE
3	400	2000	1	45	VICTOR VANADIUM BRONZE
4	400	2000	1	00	REGULAR BEARING METAL
5	400	2000	1	15	HIGH GRADE BEARING METAL

Composition No. 1. Type "C" Special Victor Vanadium Bronze.
 " No. 2. Type "B" Superior Victor Vanadium Bronze.
 " No. 3. Type "A" Regular Victor Vanadium Bronze.
 " No. 4. 81% Copper, 9% Tin, 6% Lead, 4% Spelter, Trace of Phosphorus.
 " No. 5. 84% Copper, 12% Tin, 4% Lead, Trace of Phosphorus.

Each of the samples of metals was placed on the machine twice. It will be noted that the time of run checked up exactly in each case. The bearings were placed upon a shaft, $2\frac{15}{16}$ " diameter, and the bearing surface in each case was 9 square inches. The speed throughout the test was the same, 400 revolutions per minute, 50% more load was applied to special Victor Vanadium Bronze composition, and its time of run was much greater than the other metals. The load applied amounted to 333.33 lbs. per square inch in special Victor Vanadium Bronze bearing, and 222.22 lbs. per square inch in all the other bearings.

Write for our booklet on "Vanadium Metals in Marine Construction."

VANADIUM METALS COMPANY

Frick Building, Pittsburgh, Pa., U. S. A.

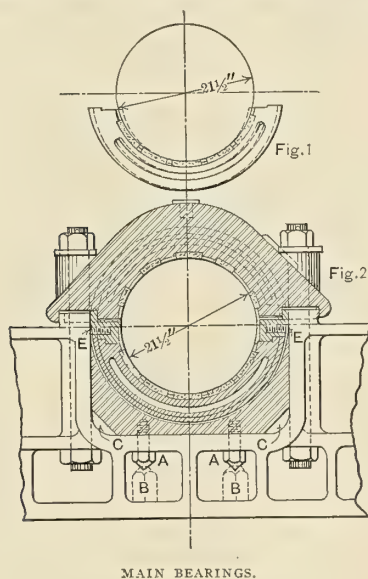
Foundry, East Braintree, Mass.

PRACTICAL EXPERIENCES OF MARINE ENGINEERS.*

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs.

Brasses of Marine Engines.

During a two years' cruise in one of our large armored cruisers, having charge of both main engines, I had some experience with brass and bronze as used in heavy journals which may or may not be new to the many readers of your valuable paper. The main bearings, crank pin and wrist pin brasses gave the most trouble, but occasionally, and apparently without cause or provocation, the saddle-pin brasses, particularly those of the intermediate-pressure and low-pressure engines, would assert themselves. The main bearings were fitted substantially, as shown in Figs. 1 and 2. The caps and removable seatings for the bottom bearings were steel castings, but the bottom bearing or shell was of brass, and fitted as shown in partial section in Figs. 1 and 2. Both the caps and bottom bearings



MAIN BEARINGS.

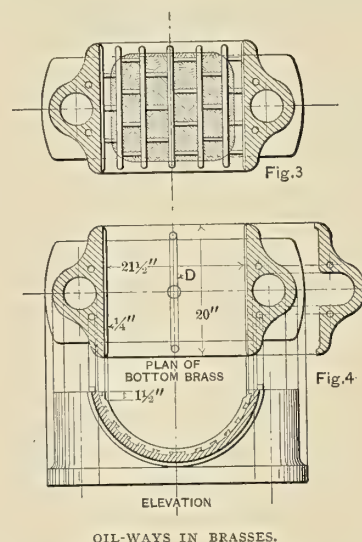
were water-jacketed and lined with white metal, or navy metal, as shown, the parting, or check pieces, being locked in position by two $1\frac{1}{8}$ -inch steel tap bolts, as shown at E, E, Fig. 2.

If heating of the bearing should occur it would seem very improbable that the bottom brass, from its being locked in position by the tap bolts, and again secured by the caps through the lip on the cheek or parting pieces, could spring enough to put a permanent set in it. Yet such is the fact. And upon turning out two of these bottom brasses that had become heated before I joined the ship to ascertain their condition, it was found later on, by caliper the brass before refitting, that they had closed in $\frac{1}{4}$ inch, as shown by the dotted lines in Fig. 1. In first looking over the brass it was thought that refitting was all that would be necessary. The loose babbitt was therefore scraped out and the oil-ways trimmed about their edges, and when all the clips were carefully wiped out the mandrel for refitting the main bearing brasses was carefully covered with a thin coating of Prussian blue and dropped into the shell as it lay upon the floor plates.

Here is where our trouble commenced, for a 5-horsepower engine, plus a team of bulls, would have been needed to turn

the mandrel in its seating, when it should have spun around easily by hand. The mandrel was lifted, and the cause of its sticking was apparent. The brass bore beautifully upon a strip of the white metal, about an inch wide, and clear across both open edges of the brass, but it never hit a single spot below this or in the crown. Then we calipered the outside of the shell carefully, and also a spare brass that was in the shaft alley, and we found that there was a difference of a scant $\frac{1}{4}$ inch between the two. My first idea was to set up the brass and bore it out to size and then turn it back into place. But as we had only five hours in which to keep the engine adrift I concluded to put in the spare, and have the old brass sprung back to size and rebabbitted at the navy yard, where we were due in about a week.

The spare was therefore fitted and turned in with the jacking



OIL-WAYS IN BRASSES.

engine, and the old brass secured upon the bulkhead in the shaft alley, and straightened and rebabbitted at the navy yard. While at the navy yard the ship's force began overhauling and readjusting the crank pin, wrist pin, saddle pin and main bearing brasses. The starboard intermediate-pressure crank pin had run more or less hot ever since I had joined the ship, and as I was assured that this set of brasses had been refitted but lately, I began a hunt for the cause of their heating.

I had both half brasses removed, and gave them a good inspection, but they seemed, without recourse to any measurements, to be all right. There were traces of the brasses having been hot enough to have started the babbitt slightly in several small spots along the edges of the oil-ways. These were carefully scraped out, and after thoroughly wiping out both half brasses and cleaning the pin they were reassembled on the pin. I now removed a No. 33 B. W. G. liner, and drove the brasses up hard, until the full power of the jacking engine would just move the main engine. With the brasses set up like this the main engine was jacked around two full turns and the brasses opened out again. The cause of the heating was then plainly in evidence, for the only bearing they had was the unshaded portion, as shown in Fig. 3.

The man who had fitted these brasses, when last overhauled, assured me that they had a perfect bearing, as shown in the

* We pay for these articles.

shaded portion of Fig. 3, and I believed him. The trouble was that some one of the oilers had let the pin get away from him, and not called the attention of the officer of the watch to it. However, the mandrel was called into use and the brasses given a thorough refit, and left as shown in the shaded portion in Fig. 3. To do this, however, it was necessary to remove .018-inch liners when the final leads were taken and the brasses set up to 31 B. W. G. Heating would spring these brasses in this manner every time.

On our first run, during a period of three days, and at a speed of 100 revolutions per minute, these brasses ran perfectly cool, and afterward, when we ran for two hours at 120 revolutions per minute, followed by a forced draft trial of four hours, at which they averaged 136.3 revolutions per minute, they remained cool. I have now described the effect, and will try and point out the cause of the springing, or changing shape of these and similar brasses. For a cause, and a very plausible one, we have not far to look.

In a table of coefficients of expansion of metals I find that the coefficient of bronze (cast) is .0000099, while that for steel (cast) is but .0000064; therefore, there is a difference between the two metals of about 1.39 times. And as the bronze expands 1.39 times as much as the steel that comprises the rest of the bearing, and must therefore go somewhere, following, of course, the line of least resistance, it naturally would close in upon the shaft or pin, causing still further heating by gripping or seizing the bearing surface of the shaft or pin.

I have seen many large engines, marine type, fitted to drive power generators, and all of those I saw built by the Union Iron Works were fitted with steel shells, white metal lined, for main bearing and crank pin, as well as wrist-pin brasses, and all of them ran all right.

When I first began erecting work for high-speed engine builders the engines were principally used for electric lighting, and the first of these were fitted with brass crank-pin boxes. Whether lined or unlined, they all gave trouble; then came the change to cast iron, white metal lined, steel castings not being as common twenty-five years ago as they are now. And at the present time to build modern engines for high duty, high speed and heavy work, with weights being cut down to the minimum, and return to brass or bronze in heavy bearings, would seem like retrograde progression. I can see no object in the use of brass or bronze for this purpose whatever.

The saddle-pin brasses of the engines in the cruiser referred to were simple, straight shells, without flanges, about $\frac{5}{8}$ inch thick, 5 inches long, and worked upon a 5-inch pin. These would always close in after becoming heated, but could be drawn back to shape by peening; but this treatment is only a makeshift job when it comes to main bearing shells for a 21½-inch shaft, especially when cored out for water service.

While serving upon one of our modern battleships some years ago, during our trial runs over the measured mile, in order to standardize the screws, the No. 1 main bearing of the starboard engine developed a heavy one-ended thump when at full speed (136 revolutions per minute). As the engines were still in the hands of the builders we could only offer suggestions, as it was up to them to locate and remedy the trouble. But in this they failed, and the engines, thump and all, were finally turned over to Uncle Sam a couple of months later. I at once began a hunt for the trouble, and was sure, from the very start, that this bearing was low. Reference again to Fig. 2 will explain how I arrived at the amount that this bearing was low, and how I remedied the trouble without turning out the brass.

I had four tap bolts made with conical heads, as shown at A, A, and replaced the original tap bolts with these. I then fitted four steel blocks, with a light countersink in each, and set them under the tap bolts on the web of the engine seating. We then lifted the main bearing cap clear of the shaft, and with

one man at each of the tap bolts began to back them out. These, being tapped into the seating for the main bearing shell, began to lift the seating and brass up to the shaft. With wrenches 10 inches long, upon the 1½-inch tap bolts, we raised the seating and brass a full 1/16 inch, until it was up to the shaft, solid. I then inserted four steel wedges, one in each of the slots C, C, in order to hold the brass up in place, and then removed the tap bolts altogether. A liner was now fitted, of proper thickness, with holes for the four tap bolts. This was pushed into place and the original tap bolts screwed back into their places. My new bolts and the steel blocks were turned into the storeroom for future use upon similar jobs.

It is needless to say that our job was a good, solid one, and that the one-ended thump entirely disappeared. I would recommend this rig when bearings are fitted similarly. When we arrived at the navy yard I turned in two sets of crank-pin brasses, one high-pressure and one intermediate-pressure, to be rebabbited. I suggested that no oil-ways be cut in them, for I would cut them as I wanted them with the ship's force.

Excepting these particular sets of crank-pin brasses all of the others had oil-ways $\frac{5}{8}$ inch wide and $\frac{3}{8}$ inch deep, and of the form shown in Fig. 3.

When the brasses had been returned on board, after they were carefully fitted and given a bearing, as shown by the shaded portion in Fig. 3, I had a chamfer cut across their open edges $\frac{1}{4}$ inch by 1½ inches, as shown in Fig. 4, but no other oil-ways were cut in the bottom halves. In the top halves, in addition to the oil-ways as cut in the lower halves, I ran a channel clear across the crown of the brass, thus joining the three oil holes, as shown by the dotted lines, these channels being $\frac{3}{4}$ inch wide and $\frac{1}{4}$ inch deep. I thus gained about 115 square inches in the projected area of the bearing surface over the former oil-ways. The idea of departing from fixed rules and practices made the ancient and honorable mechanics of the navy yard, who watched these bearings being fitted and the oil-ways cut, shake their venerable heads with awe and amazement. All sorts of trouble was predicted for us, and some were willing to believe that the number of minutes these brasses would run could be counted upon the fingers of one hand.

However, as these men were to take no active part in any crank-pin drill that we might bring upon ourselves while at sea their sarcasms were wasted, for they fell upon deaf ears. These brasses were all well fitted, and given a perfect bearing both top and bottom, then put up, and the engines jacked around, with the brasses and pin dry, in order to see if they were parallel; then they were taken down and examined, and when finally set up and adjusted the leads showed No. 31, B. W. G.

After leaving the yard these brasses ran cool and gave no trouble whatever, and they made, in round numbers, before taking down again some 13,000 nautical miles. When they were finally opened up for inspection a set of leads showed .018 inch clearance, and the working surfaces were like mirrors. With this clearance they did not have a sign of a pound, although when feeling them at sea the mixture of oil and lather would have a perceptible squash, and was thrown from the pins as white as snow. About .010 inch was the limit of slack on any of the other pins before they became noisy. This I attributed to the lather being forced into the large oil channels, and therefore being unable to cushion the pins.

E. A. BLACKWELL, U. S. N.

Kingston, N. Y.

The average speed of the United States battleship *South Carolina* on her official twenty-four-hour trial trip was 18.85 knots. This is a creditable increase over the 17.68 knots attained on her preliminary acceptance trial.

Stop Valve Troubles.

The stop valves of marine engines are operated either by a handle or by a hand-wheel. In the first case a slide valve is moved by the handle, and in the second the turning of the hand-wheel gives way to the steam. It is difficult to say which method is better, but each has certain advantages under certain conditions. By means of a slide valve the revolutions are altered much more quickly than by a lift valve and hand-wheel, and such a valve must, therefore, be accompanied by a throttle valve, which may be used in heavy weather to diminish the racing of the engine as much as possible. It is, however, difficult to make a throttle valve perfectly steam tight, and most engineers know that with the throttle valve closed, many engines cannot be slowed down further than to half speed, due to the leaking of the steam. There is less

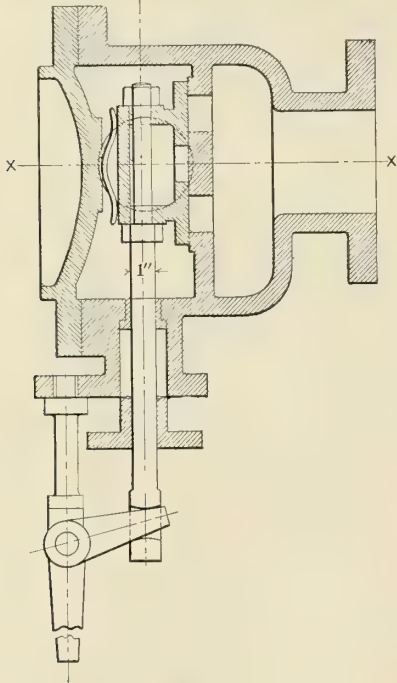


FIG. 1.

leakage with the lift valve than with the slide valve, and this is remarkable, since the slide valve has such a large area that some means have to be provided for cutting off a portion of it from the action of the steam pressure. From the foregoing it is evident that a slide valve is better for high-speed engines, as there the effect of racing is more disastrous.

The diameter of the engine stop valve need not be the same as that of the main steam pipe. This is seen when closing from a wide-open position, a lift valve, the lift of which is one-quarter of the valve diameter. If six turns of the hand-wheel are necessary to completely shut the valve, no alteration in the revolutions of the engine will be seen until the fourth turn of the hand-wheel has been made, while the last two turns will stop the engine entirely. For this reason the stop valves of the engines in the German navy have a diameter of two-thirds the diameter of the steam pipe. The cost of the valves is thus lower and the weight less.

On the trial trip of the tug *E* while maneuvering, the lift valve was fully opened, and then the telegraph indicating stop, the hand-wheel was turned, but this took so much time that the handle of the reversing gear was put square too late and the boat touched the shore. The engine immediately began racing severely, indicating that some blades were off the propellers. On examination it was seen that all four blades had been broken. In this case a slide valve would have prevented the mishap.

Faults in the construction of slide valves are possible, as the following will show. On a compound engine of 250 indicated horsepower a slide valve (Fig. 1) had been fitted, and when steam was on the engineer was frequently troubled by the falling down of the valve, thus opening a passage for

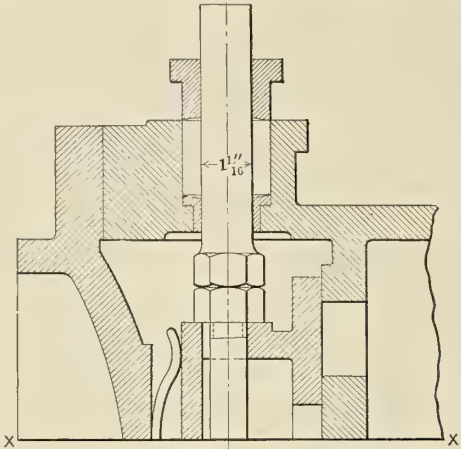


FIG. 2.

steam when it was not desired. It was thought at first that the valve was blown down, due to the great velocity of the steam. The engineer, therefore, screwed up the packing gland so that the resistance of the packing was greater than the force of the steam, but this made closing of the valve somewhat difficult.

On another engine the stop-valve operating mechanism was made as indicated in Fig. 3. The crank *A* turned a rod on which an eccentric *B* was fixed. The eccentric rod moved the valve, which was set horizontally. The action of the steam

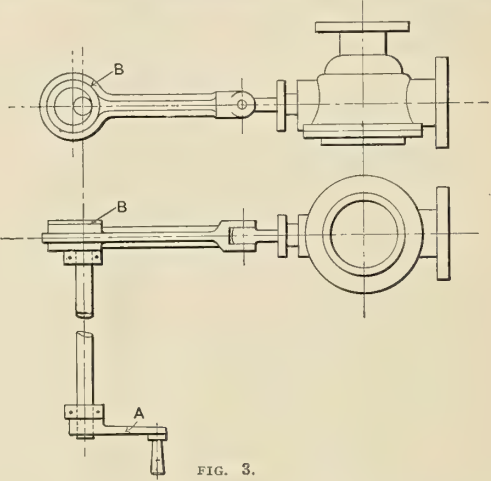


FIG. 3.

could not move the eccentric, but less pull was required for opening the valve than for closing it. After some time the reason for this was better understood, and the arrangement was altered. The steam pressure was 192 pounds per square inch, the diameter of the valve rod 1 inch, and as this rod was led through a stuffing box on one side only, the force acting downwards on the valve would be

$$\frac{3.1416}{4} \times (1)^2 \times 192 = 150 \text{ pounds.}$$

This force acting in a downward direction on the valve was resisted by the frictional resistance of the valve plus the frictional resistance of the rod in the stuffing box. Since these two resistances amounted to less than 150 pounds, the valve was moved downward.

The valve was changed as shown in Fig. 2. A check nut in

the form of a rod which extended through the top of the valve case was provided and a stuffing box was fitted. The diameter of this rod was made $1 \frac{1}{16}$ inches, thus a resultant force acting upwards on the valve was obtained of

$$\frac{3.1416}{4} \times [(1 \frac{1}{16})^2 - (1)^2] \times 192 \text{ pounds.}$$

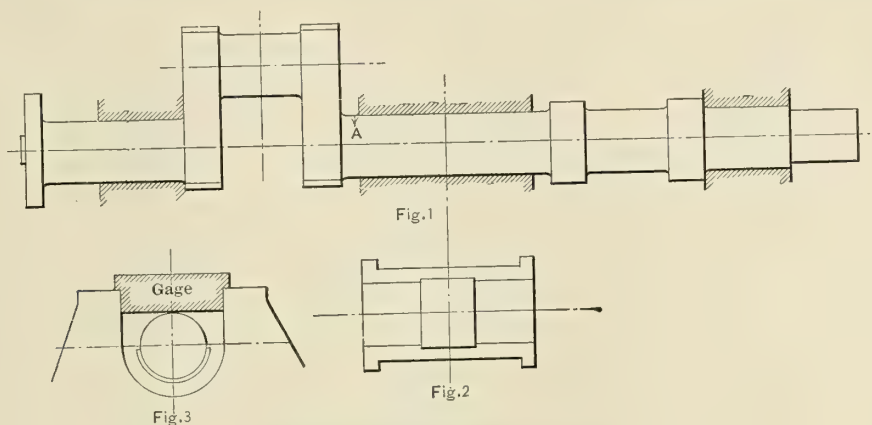
This force was about equal to the weight of the valve and rod, so that the valve was then perfectly balanced. After this was done the force of the steam was no longer felt on the valve.

D. K.

A Broken Crank Shaft.

The bearings of shafts and brasses of pins and journals are nearly always designed for adjustment for wear. A liner and some thin plates are inserted between the brasses, so that when these are somewhat worn a thin plate may be taken out. After all the thin plates have been taken out, the liner must be filed off until the brasses are to be renewed or relined. In the latter case a new liner must be made. There is no objection to taking away some of the thin plates from the brasses of a pin, but in the case of a shaft resting in three or more bearings, care should be taken that more plates are not taken out of one bearing than from the other, as in that case the shaft may be subjected to severe bending moments.

The crankshaft of the compound engine of the tug *T* rested in three bearings, Fig. 1, the center bearing being very long.



DETAILS OF SHAFT BEARINGS ON TUG T.

Due to the length of the center bearing the outer bearings wore more than the middle one. The engineer took off the thin plates from the outer bearings without scraping out the middle one. Therefore, when the caps were screwed down, the shaft necessarily bent. The last time this was done the boat was towing a small ship on a river, the engine working about half power. After a few hours a second ship was picked up and the stop valve open wide. After proceeding in this manner for about half an hour, the crankshaft broke at *A* close to the edge of the center bearing. It is evident that the shaft had been bent about this point when the caps of the outer bearings were screwed down. Another tug took over the tow and the boat herself was towed to the engine works, where a new crankshaft was ordered. The broken shaft was made to Lloyd's requirements, but the needlessly severe bending moments caused the fracture. When the new shaft was fitted, the center bearing was recessed, as indicated in Fig. 2, so that the wear might be equalized.

It is essential that the wear in the bearings may be regularly controlled by the aid of gages for each bearing, since with large engines it is a very troublesome job to lift the shaft. On one steamer, where there were continual changes

in the engine-room staff, it was thought that the crankshaft had worn its bearings unduly and dropped too much, so that the renewal of the end brasses would be necessary. The engineers hunted for a gage but could not find it. Finally one of the firemen remembered having seen such a plate and found it under the floor plates. By using it it was found that the shaft had not dropped more than $1/16$ inch, so that the renewal of the brasses was unnecessary; thus considerable time and money were saved.

D. K.

A Fractured Rudder Head.

In January, 1899, while the steamship *Morehead* was steaming against a severe northwest gale in mid-Atlantic, a peculiar accident in the nature of a break occurred to the rudder post. Fortunately, the position of the break was just above the deck bearing, and it extended diagonally to the quadrant head.

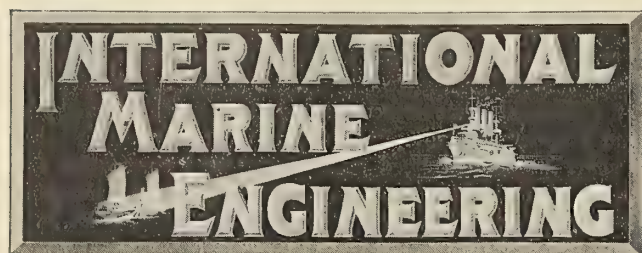
Naturally, the deck officers assumed the responsibility to effect repairs. Securing considerable timber of all dimensions from the cargo they proceeded to build a jury rudder, about 12 feet by 16 feet, with the intention of rigging it to the stern. However, the folly of this was soon apparent, as rigging timber to the stern in a heavy gale was entirely out of the question. As usual, they then sought suggestions among the engineers, and the credit for successful repairs must be given to the men "under the grating."

It was decided to use the spare bottom-end brasses to clamp around the fractured rudder post, as nothing else available

would answer as well. In calipering the post it was found to be exactly 12 inches in diameter. The brasses were bored for the crankpins, which were 14 inches in diameter, consequently some means had to be devised to fill in between the brasses and the post. Many ideas were submitted, each receiving more criticisms than approvals, until the idea of stripping the 2-ton chain block and winding the chain around the post to fill the space was suggested.

When the brasses were finally brought aft to complete the job, it was found that they were entirely too wide to fit between the quadrant head. In measuring it was seen that by the removal of one cheek from each brass they would make a suitable fit. To cut the cheeks away it was necessary to drill about twenty $\frac{3}{4}$ -inch holes around each cheek and split it away with a flogging chisel and "monday." After this was finished the brasses securely clamped to the chain-wound rudder post.

The engineer's repair job occupied about six hours to complete, making a thoroughly sound repair. It proved entirely satisfactory, as severe gales and heavy seas were met with for several days after without affecting it in any way. Port was finally reached, where an entirely new post was made.



Published Monthly at

17 Battery Place New York

By MARINE ENGINEERING, INCORPORATED

H. L. ALDRICH, President and Treasurer
and at

Christopher St., Finsbury Square, London, E. C.

E. J. P. BENN, Director and Publisher

HOWARD H. BROWN, Editor

AMERICAN REPRESENTATIVES

GEORGE SLATE, Vice-President

E. L. SUMNER, Secretary

Subscription Manager, H. N. Dinsmore, 83 Fowler St., Boston, Mass.
Branch } Philadelphia, Machinery Dept., The Bourse, S. W. ANNEX.
Offices } Boston, 643 Old South Building, S. I. CARPENTER.

Entered at New York Post Office as second-class matter.

Copyright 1910, by Marine Engineering, Inc., New York.

INTERNATIONAL MARINE ENGINEERING is registered in the United States
Patent Office.

Copyright in Great Britain, entered at Stationers' Hall, London.

Notice to Advertisers.

Changes to be made in copy, or in orders for advertising, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following. If proof is to be submitted, copy must be in our hands not later than the 10th of the month.

Mechanical Gearing for Turbines.

The possibilities of the commercial application of the marine steam turbine in the event of the development of a successful reduction gear so that the most efficient speed of both the turbine and propeller can be realized without undue loss have been widely discussed, and the value of such a device is beyond question. Of exceptional interest, therefore, are the results obtained by Mr. Parsons with his experimental gear on the *Vespasian*, an account of which is published on page 253. Although at the time Mr. Parsons' paper was prepared only a few tests had been carried out, yet enough had been done to show that under normal full-speed steaming conditions an increase of about one knot was realized with the turbine-gear engines over the reciprocating engines with the same coal consumption. It is claimed that the turbine and gearing has given no trouble and has run with little noise or vibration. Whether long and hard usage will impair the efficiency of the gear, of course time alone will tell, but it is under such conditions that the gear must operate if it is to be universally applied to slow-speed merchant vessels, and the matter of durability will be watched with interest.

Fire Boats.

We are publishing this month detailed descriptions of the latest additions to the fast-growing fleet of American fire boats. A glance at these designs emphasizes the fact that each problem in the design of this special type of boat must be studied by itself. Conditions vary so widely in different harbors that qualities which would at first thought seem essential in a boat designed for fire fighting must either be eliminated entirely or greatly modified. In the Chicago fire boats, for instance, which were described in our September, 1908, issue, speed, which at first thought would seem a prime necessity in a fire boat, was of little moment, since the narrow and obstructed river in which they were to operate imposed a practical limit to the speed at which the boats could be navigated. Similarly, by reason of the nature of the harbor, it was of exceptional advantage for the pilot to have direct and complete control over the movements of the vessel, and consequently the unique system of combined turbine and electric drive controlled directly from the pilot house was of special advantage in these boats. In the new Boston boat, described this month, we again find a special design to meet special conditions. In this case natural conditions were the deciding factor in the design of the hull. It was found necessary, on account of the shallow draft in many parts of the harbor and the presence of a large number of draw-bridges and the prevalence of heavy ice in winter, to build a hull of exceptional local strength to withstand the continual rough usage due to contact with such obstructions. The hull was therefore built of wood instead of steel, and sheathed with copper in order to prevent fouling. Another unique feature of the Boston boat which will undoubtedly cause comment is the use of the smokestack as a water tower. Besides decreasing the cost of installation, this obviates the necessity of exposing a man in a dangerous position where he has little opportunity to escape a sudden blast of flame or falling debris.

Members of the American Society of Naval Architects who attended the annual meetings of the society in New York in 1908 will recall the pertinent criticisms of fire-boat designs made by the chief of the marine division of the New York fire department. According to Chief Kenlon, speed, large boiler capacity, pumps of large capacity capable of delivering the water at more than 150 pounds pressure, combined in a hull of not more than 10 feet draft or 120 feet length, would represent good fire-boat practice. To fulfil these conditions water-tube boilers and centrifugal pumps would seem to offer special advantages, while the use of steam turbines would give opportunity for a still further reduction in weight. Oil fuel might also be used to advantage on such a boat, as it offers a ready means of getting up steam quickly and of maintaining full boiler pressure while the boat is in operation.

Engineering Efficiency in the Navy.

Marine engineering in the navy naturally falls under two heads, designing and operating. Both branches are closely related, and they must receive equal attention in order that the highest efficiency may be maintained both from a military and from an engineering standpoint. Military efficiency, in fact, now depends very largely upon engineering efficiency, since practically every function performed by a modern warship is controlled by power. But the best efficiency can only be obtained when a well-designed ship is operated by expert engineers. The problem of engineering efficiency in the navy therefore resolves itself into the provision of a suitably trained corps of designers of broad experience and exceptional ability and the improvement of the work of the engineer officers and engine-room and fire-room forces aboard ship. According to advices from the Navy Department, good progress is being made in both these directions in the United States Navy.

In the first place, it is natural to expect that the latest vessels should show increased economy in fuel and oil consumption over those of earlier design, due to the improvements which are continually being made in naval boilers, engines and auxiliaries. Recent developments in the use of superheated steam, forced draft, improved methods of firing, better condenser practice, the adoption of centrifugal pumps and steam turbines for certain classes of work, the more extended use of electric power, and improvements in the design of electric machinery have all helped to bring about increased efficiency in the newer vessels. Economy from such sources, however, is more or less a matter of course, as it is the natural outcome of the progress of engineering science, but aside from such improvements some remarkable records of efficiency and economy have recently been made which are the direct outcome of the efficient administration of the Bureau of Steam Engineering and the commendable policy of the Navy Department in arousing the ambition of the engineer force by opening the way to promotion and advancement as a reward for ability and efficient work.

As a result of such methods, vessels which have been in service from five to ten years are now making higher speeds on greater displacements than they attained on their official acceptance trials, where there was every incentive and every precaution was taken on the part of the builders to make a record showing. Furthermore, these records have been made under cruising conditions, with ordinary coal and without placing the ship in dry dock to clean the hull. Increased speed under such conditions of added resistance means that the naval engineers are getting far more than the designed horsepower from the main engines. That this is being done without any concessions to economy is evident from the fact that since December the average coal consumption of all naval vessels per knot run at a given speed has decreased 5 percent and at the same time the average mileage per

gallon of lubricating oil has increased 8 percent. In individual cases, as noted elsewhere in this issue, the saving in coal and oil has been even more marked. A remarkable decrease in the expenditures for packing is also reported. Results such as these can only be obtained by the most careful attention to details and the maintenance of a high standard of efficiency in the engineering personnel.

Efficiency in this case, as in a good many others, is largely due to competition. Until recently very little has been done in the way of direct encouragement for the engineer force on naval vessels, but now steaming economy competitions are held and cash prizes are awarded to the ship showing the best general efficiency and economy in coal consumption. Not only is there a direct reward in the shape of money to be gained as a result of general excellence, but there are also opportunities for advancement and promotion to positions in the manufacturing departments in navy yards. Furthermore, the future designers of naval machinery are to be appointed from the engineer force by a process of selection in which ability and practical results will be the principal consideration. Ten engineer officers who have had at least three years' sea service will be selected each year and given a two years' post-graduate course of study in the new school of marine engineering at Annapolis. It is expected that the combination of theoretical and practical training which these men will receive, coupled with the fact that they are already men of achievement, will result in developing the highest type of engineering ability and efficiency for this important branch of the service. A complete account of the organization and work of this school will be published in our next issue, so that our readers can judge for themselves of the value of this factor in the efficiency of naval engineering.

No discussion of engineering efficiency in the navy would be complete without some reference to the standard of naval specifications and the cost of repairs to naval machinery. As compared with merchant practice, United States naval specifications are so much more severe that the first cost of naval machinery is greatly in excess of that for merchant vessels. This fact has led to much criticism by engineers engaged in commercial work, and it has not entirely escaped the notice of observant taxpayers. The increased first cost of naval machinery, however, has proved a wise investment in most cases, for it has resulted in a lower cost of repairs per horsepower than can be shown by any merchant fleet in the world, and there are few, if any, large power plants on shore that can show as good or better results in this respect. In fact, the money saved in repairs represents a high rate of interest on the increased first cost of the machinery. Not only this, but the efficiency of the ship from a military point of view is greatly enhanced by the infrequent necessity for repairs and the ability of the engineer force to effect the slight repairs necessary on board ship without taking the vessel to a navy yard.

Progress of Naval Vessels.

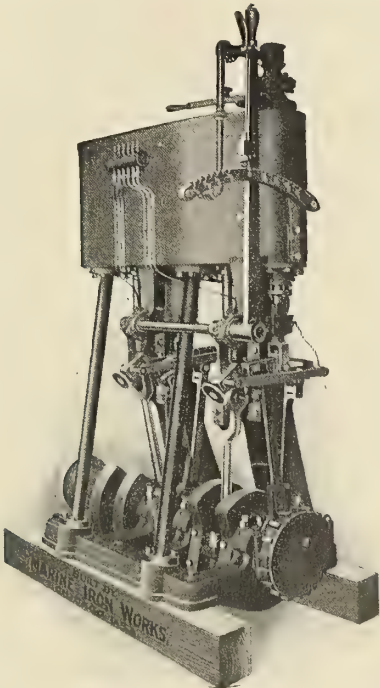
The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

BATTLESHIPS.					
	Tons.	Knots.		Apl. 1.	May 1.
North Dakota	20,000	21	Fore River Shipbuilding Co.	99.7	100.0
Florida	20,000	20¾	Navy Yard, New York	59.0	63.4
Utah	20,000	20¾	New York Shipbuilding Co.	68.5	72.0
Arkansas	26,000	20½	New York Shipbuilding Co.	19.5	24.0
Wyoming	26,000	20½	Wm. Cramp Sons	15.7	19.0
TORPEDO-BOAT DESTROYERS.					
Paulding	742	29½	Bath Iron Works	81.1	86.8
Drayton	742	29½	Bath Iron Works	73.6	77.6
Roe	742	29½	Newp't News Shipbuilding Co.	81.4	85.1
Terry	742	29½	Newp't News Shipbuilding Co.	79.9	82.4
Perkins	742	29½	Fore River Shipbuilding Co.	67.7	72.9
Sterrett	742	29½	Fore River Shipbuilding Co.	66.9	71.4
McCall	742	29½	New York Shipbuilding Co.	56.8	66.9
Burrows	742	29½	New York Shipbuilding Co.	56.2	65.6
Warrington	742	29½	Wm. Cramp & Sons	65.5	67.5
Mayrant	742	29½	Wm. Cramp & Sons	69.7	72.6
Monaghan	742	29½	Newp't News Shipbuilding Co.	17.7	18.3
Trippe	742	29½	Bath Iron Works	25.3	31.9
Walke	742	29½	Fore River Shipbuilding Co.	19.2	27.5
Ammen	742	29½	New York Shipbuilding Co.	19.4	30.9
Patterson	742	29½	Wm. Cramp & Sons	12.1	17.8
SUBMARINE TORPEDO BOATS.					
Salmon	...	...	Fore River Shipbuilding Co.	91.7	92.7
Seal	...	...	Newp't News Shipbuilding Co.	47.1	48.9
Carp	...	...	Union Iron Works	45.7	47.6
Barracuda	...	...	Union Iron Works	46.1	47.6
Pickrel	...	...	The Moran Co.	43.3	46.4
Skate	...	...	The Moran Co.	43.3	46.1
Skipjack	...	...	Fore River Shipbuilding Co.	35.3	37.6
Sturgeon	...	...	Fore River Shipbuilding Co.	34.7	36.7
Tuna	...	...	Newp't News Shipbuilding Co.	21.2	22.2
Thrasher	...	...	Wm. Cramp & Sons	4.3	4.7

ENGINEERING SPECIALTIES.

An Engine with a Record.

Our attention has recently been called to the remarkable performance of a medium-sized compound marine engine, built about four years ago by the Marine Iron Works, Clybourn and Southport avenues, Chicago, Ill. During the four years in which this engine has been in service, it has been con-



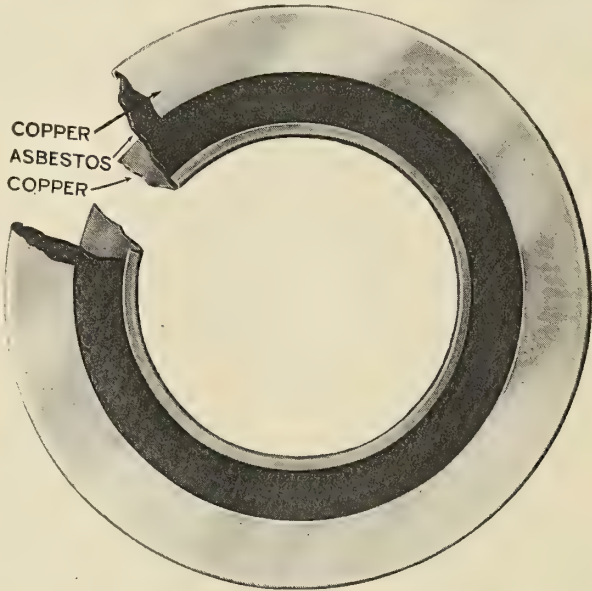
stantly engaged in hard, steady work in a fishing tug, the owner of which states that during this entire period the expense for repairs has been less than 25 cents (one shilling). This is a record which is certainly remarkable and testifies to the excellence in the design and construction of the engine.

The engine is of the fore-and-aft compound type, having

cylinders 8 inches and 17 inches diameter, with a stroke of 12 inches. The high-pressure cylinder is fitted with a balanced piston valve having expansion rings. The low-pressure cylinder is fitted with a double-ported slide valve. The engine is of the heavy service, "bar" guide design, having hollow cast iron back columns and front columns of turned and polished forgings. The crankshaft is a solid forging, finished to 4 inches diameter, with crank-pins of the same diameter. The principal wearing parts are fitted up with adjustable take-up attachments. Appliances are fitted for lubricating each moving part. Steel and bronze are used to a considerable degree, to give strength and yet minimize the weight. The builders state there is no fancy work about the engine, but that it is intended to be a good, plain, substantial machine, which will bring about economy through low cost of repairs. The same company also builds single and double high-pressure, heavy service, triple-expansion stern and side paddle wheel engines ranging from 25 to 700 horsepower.

The National Safety Gasket.

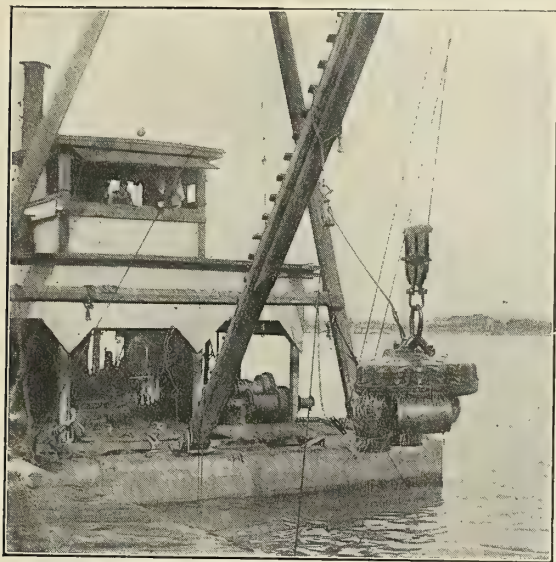
The Dyna-Como Company, Inc., 161 Devonshire street, Boston, Mass., is placing on the market the National safety gasket. This gasket is made of copper and asbestos equally distributed, forming a metal and fiber bearing on each flange. Since the asbestos is held by the copper, it is impossible for it to spread after once being made tight. It is claimed that the



gasket can be quickly and easily inserted; that it will withstand vibration, contraction and expansion; that it will make a perfectly tight joint on pipe lines, where the steam is frequently turned on and off; that it will not spread nor blow out; that it is safe and does not have to be followed up; and, finally, that it can be taken out of the flange and used over many times. This latter claim is, of course, of great importance from an economical standpoint. The gasket is designed to hold steam, water, gas or air pressure.

Lifting Magnets for Salvage Work.

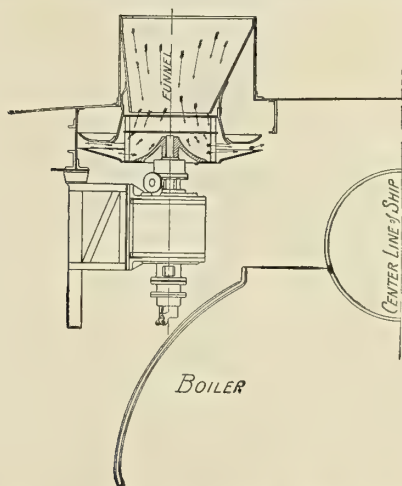
Recently a barge which had been towed from Pittsburg to New Orleans, laden with 1,500 tons of wire nails in kegs, steel barrel hoops, staples and barb wire, broke loose from the tug which was landing her, struck the wharf and sank in water about 100 feet deep where the current was excessive. The salvage of this cargo was accomplished by means of electric-lifting magnets supplied by the Cutler-Hammer Manufacturing Company, Milwaukee, Wis. This is the first time that an



electric-lifting magnet has been used under water, and the success of the undertaking has occasioned considerable comment. The largest haul which was made with the magnet consisted of five kegs of nails weighing 100 pounds each; one bundle of hoops weighing 79 pounds; one bundle of fence wire, weighing 155 pounds; thus aggregating somewhat over 700 pounds. It is expected that one of the most important results of this experiment will be the reduction of insurance rates on barges used in the iron and steel cargo trade.

Vertical Turbo-Fans for Forced Draft on Shipboard.

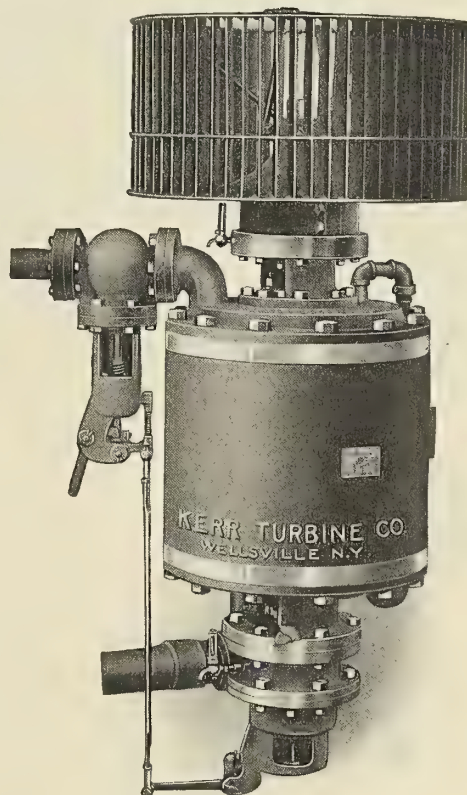
The 50-horsepower, seven-stage vertical turbo-fan which we illustrate is one of eight designed by the Kerr Turbine Company, of Wellsville, N. Y., for supplying forced draft to the boilers of the United States torpedo boat destroyers *Sterrett* and *Perkins*. These turbo-fans operate at a maximum steam pressure of 265 pounds, and non-condensing against 5 pounds back pressure. The fans, of the American Sirocco type, are



placed to take air from the outside through funnels on the deck and discharge it into the fire-room through adjustable cone-shaped casings. Two fans, each operating at 1,655 revolutions per minute, deliver 40,000 cubic feet of free air per minute into each engine room, maintaining within a pressure equivalent to 4 inches of water.

The installation arrangement is shown in the line diagram. The turbines are made right and left, and are arranged in pairs, one pair delivering into each fire-room. One unit is bolted directly onto a vertical stanchion on each side of the

boiler. It is evident from the diagram that the space restrictions are quite severe. Small diameter of the turbine is an important requirement, and this was made possible without reducing the power below the desired limit, only by using seven rotors, each 12 inches in diameter. The use of many stages with light rotors of small diameter in these turbines also overcomes trouble from gyroscopic action better than using few rotors of larger diameter. Experience has shown that in marine work the gyroscopic action of large, heavy



turbine wheels running in a horizontal plane and with bearings close together subjects the bearings to heavy side pressure as the boat rolls.

It is claimed that Kerr turbines are meeting with considerable favor for driving electric generators on shipboard and for driving marine auxiliaries, because of their economy, compactness, reliability and the absence of oil from their exhaust. A turbine is always clean in appearance and seldom requires attention. The test economy is maintained indefinitely, as there are no internal parts to rub and wear. This is of special advantage in driving fans and pumps where the grinding of dirt and cinders on the rubbing surfaces of a reciprocating unit would render more attention necessary.

Invincible Nozzles for Fire Boats.

The efficiency of a fireboat depends largely upon the efficiency of the nozzles, since they must have a low friction loss and deliver solid streams of water. Friction loss is materially reduced by large waterways, by the absence of sudden changes in section and by avoiding impact. Solidity of the stream, on the other hand, is largely a matter of experiment, and the higher the pressure the more difficult it is of attainment. Furthermore, all joints in the nozzle must be watertight, and yet the stream must be easily directed. To meet these requirements the Invincible nozzle has been designed by Andrew J. Morse & Son, Inc., Boston, Mass. This nozzle carries a partition well down into the throat of the Y, and separates the water into two parallel streams with, it is claimed, practically no loss or eddies. The water thus travels

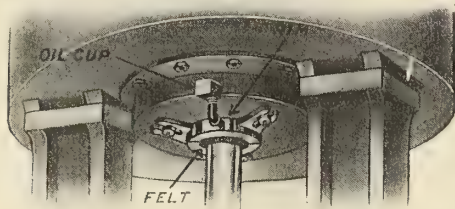
through two arms of uniform size and without obstructions. The two streams thus run parallel before uniting in one, thus avoiding friction losses. After thus uniting, the stream passes through a smooth play pipe, and the water is discharged



through a properly shaped tip, giving a solid stream, as shown in the illustration. The illustration shows the new Boston fireboat *Engine 47*, a description of which will be found elsewhere in this issue.

The Peerless Oiler and Wiper.

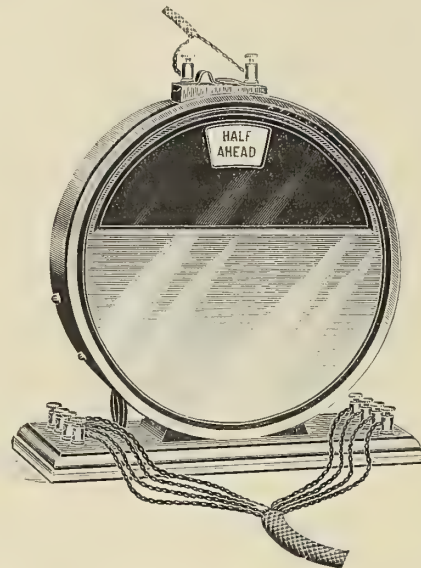
The Peerless oiler and wiper manufactured by the Peerless Oiler & Wiper Company, 100 William street, New York, has been designed to obtain proper lubrication between the piston rod and the packing. Steam is known to dissolve any oil, grease or compound used in packings, so that with ordinary packing the engineer can never be sure how long it is going to last. Furthermore, when fiber rod packing wears, leaks are taken up by tightening up the gland studs, so that the packing wears further, losing its elasticity, increasing the friction on the piston rod, interfering with the proper lubri-



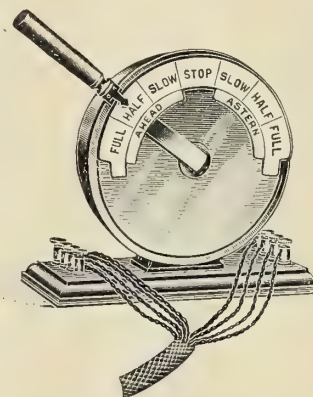
cation of the rod and even scoring it. The Peerless oiler and wiper is attached to the gland studs in such a manner that the felt encircles the rod and a brass oil cup is connected to the device. The cup has an eighth-inch hole, and the hole is covered with felt. The oil permeates the felt and passes through the small pipe to the felt that encircles the rod. It is claimed that the action of the oil on the felt is the same as a lamp wick, giving positive action with every stroke of the rod. It is claimed, also that this continuous lubrication of the rod with every stroke reduces friction to a minimum and prevents the scoring and wearing of the rod. Furthermore, it is claimed that this device will result in a considerable saving of oil, since none of the oil applied to the rod is wasted as is the case when swabbing or the drip cup method of lubrication is used.

An Electric Engine-Room Telegraph.

The device described below was invented for the purpose of communicating from the bridge to the engine room on board ships. It consists of a telegraph worked electrically, thus



doing away with chains or moving wires. The movable parts are very light, consisting of an elliptical piece of soft iron mounted on an arbor, a disc of fiber and an aluminum wheel, on which are stamped the signals. The iron ellipse rotates between electro-magnets, and is locked in position by an iron core working in a solenoid. There is also a magnetic brake employed to damp the swing of the rotating parts, stopping the wheel instantly when the desired signal is in position. The receiving part of the telegraph can be made with the signals stamped on a fixed plate and a hand to indicate the signal to which it is required to draw attention. The core of the



solenoid closes an electric bell circuit, causing the bell to ring every time that the lever of the telegraph is moved. The instrument can, of course, be used for other purposes, and it could be made to repeat or a bell could be run from the engine-room to signify that the signal had been received. As it is impossible for the signal to remain in an indeterminate position this would be sufficient.

This device is being placed on the market by Walter P. Notcutt, 8 White street, Moorfields, London, E. C.

PERSONAL.

COMMANDER HAROLD P. NORTON, U. S. N., for nearly four years chief of the designing division of the Bureau of Steam Engineering, Navy Department, at Washington, was relieved

of the foregoing duty on May 1 and assigned to take up the duties as assistant in the office of the "Aid on Inspections," one of the four new branches in naval administration created under the Secretary of Navy's reorganization plan. Commander Norton is succeeded by Commander C. W. Dyson, with Lieut.-Commander John Halligan as assistant.

REAR ADMIRAL PHILIP HICHBORN, U. S. N., retired, former Chief Constructor of the Navy, died at his home in Washington, May 1. He was born at Charlestown, Mass., March 4, 1849, and was graduated from the Boston High School at the age of sixteen. Shortly afterwards he was indentured to the Government as a shipwright apprentice at the Charlestown navy yard. In August, 1861, he obtained a position as carpenter of the clipper ship *Dashing Wave*, bound for San Francisco. While on the Pacific Coast the former chief constructor was connected with the Pacific Mail Steamship Company and the California Navigation Company. He soon, however, again entered the Government service, and was assigned to the Mare Island Navy Yard. While on duty at the League Island Navy Yard in Philadelphia as naval constructor in 1884 he was detailed to make an inspection of foreign dockyards. This investigation covered a period of nearly five months. He was then ordered to Washington as assistant to the chief of the Bureau of Construction and Repair and as naval constructor at the Washington Navy Yard. He was appointed chief constructor in 1898. Some of his more noted achievements consisted in the introduction in the navy of fireproofed woodwork and the design of an inclined turret extensively copied in foreign navies and largely used in America.

TECHNICAL PUBLICATIONS.

The Marine Steam Engine. Tenth edition. By R. Sennett and H. J. Oram. Size, 6 by 9 inches. Pages, 502. Illustrations, 414. New York, 1909: Longmans, Green & Company. Price, \$6.

So popular has this work become that a new edition has appeared every two years for the last eight years, and with each edition certain additions are made to bring the book thoroughly up to date. In the present edition, the additions of particular interest are in connection with the chapters dealing with the steam turbine and the torsion meter. The first two editions of the book were written by the late Mr. Richard Sennett, but after his death, owing to the great changes which had taken place in marine engineering, it required to be practically rewritten in order to modernize it. This task was undertaken by Henry J. Oram in preference to preparing an entirely new work, but, on account of the many revisions and additions, little now remains of Mr. Sennett's work. As showing the rapid development of marine engineering in recent years, it is noteworthy that since Mr. Oram's first association with the book complete chapters on watertube boilers, oil fuel arrangements, internal combustion engines and the marine steam turbine have been added. Considerable attention is given to the care and management of marine engines and boilers, and, taken altogether, the work is one of the most complete and valuable treatises on marine engineering which is available.

Scientific American Handbook of Travel. Compiled and edited by Albert A. Hopkins. Size, 5 by 7¼ inches. Pages, 503. Illustrations, 500. New York, 1910: Munn & Company, Inc. Price, flexible cloth, \$2 net; full leather, \$2.50 net.

To the uninitiated traveler a sea voyage is a novelty, and either through lack of knowledge or through misinformation he sometimes fails to make suitable provision for his own comfort, which with a little forethought he might easily have

done. This book gives more information regarding sea travel to-day than any other which has been published in recent years. In addition to this, it is a valuable guide book for European travel. It is not intended to take the place of descriptive guides like Baedeker, but it will be found an almost indispensable complement to such books. Among things of interest to the sea traveler, the book describes what is going on shipboard from the lookout and captain's bridge to the submarine bell detector on the keel. The personnel and its officers and men are minutely described, also the question of supplies, fees, etc., are adequately treated. A statistical and historical account of steam navigation, the size, tonnage, speed records, number of passengers landed, etc., are given. Detailed information is given as to the sea and its navigation; distances visible at sea, lights, signals, international code, wireless, semaphores, etc. The book should be of interest not only to the traveler but also as a reference book for the library.

The Story of the American Merchant Marine. By John R. Spears. Size, 5¼ by 7½ inches. Pages, 340. Illustrations, 16. New York, 1910: The Macmillan Company. Price, \$1.50.

This book cannot be considered a complete history of the American merchant marine. It is rather a study of the reasons for the growth and decline of shipping in the United States. The author points out in a clear manner how in the early history of the country the people, particularly in New England, naturally turned to the sea as a profitable means for employment, both for fishing and trading. American sailors in those days were more than seamen; they were very apt to be shipbuilders, fishermen, seamen, traders and inventors as well, men who not only were daring and skillful navigators but also shrewd traders capable of meeting the competition of the keenest merchants in the world. It was due largely to the fact that the seaman was also a merchant that the carrying trade received such an impetus in the early history of the nation. In those days, in spite of almost overwhelming odds, young men having ambition and ability worked their way to the command of ships before they were old enough to vote, and it was to this opportunity to cultivate an ambition for a seafaring life that the author attributes the development of the master mariner who, in later years, made the American flag supreme upon all the seas of the whole world through the medium of the famous clipper ships. All through the book the author emphasizes the fact that the supremacy of any nation upon the sea is a matter of the survival of the fittest, disclaiming the idea that any successful merchant marine is to-day upheld by government aid or protective measures.

As to modern conditions, the author attributes the decline of the American merchant marine very largely to the blind policy of neglecting to adopt modern developments in steam engineering at a time when the steamship was displacing the sailing vessel, as instances of which he quotes the adherence of American designers to paddle wheel propulsion when other nations were turning to the screw propeller and also the lack of experience of early marine engine designers.

The author opposes subsidy as a means of upbuilding the American merchant marine, and states that if one-half the ingenuity and energy that have been used in arguing for the subsidy policy had been expended in evolving a revolution-making type of ship, America would have had long since a merchant marine worthy of her flag. The author's idea of a revolution-making type of ship seems to be the gas-driven ship, and he takes American marine engineers to task for not producing out of hand such an epoch-making ship. As a matter of fact, American gas engine practice is not only keeping pace with the world but, in many instances, anticipating developments elsewhere. We venture to predict that if the gas-

driven ship becomes a reality the United States will be one of the first to make it so.

It is admitted that the American flag can be restored to the high seas if the nation is willing to buy ships and pay for their maintenance, but the author claims that such a procedure would be useless except as a provision for a naval reserve and that the Stars and Stripes will never again be triumphant upon the high seas until the American environment evolves once more by natural processes the nautical unit as efficient for the modern day as was the American sailing ship in days long past.

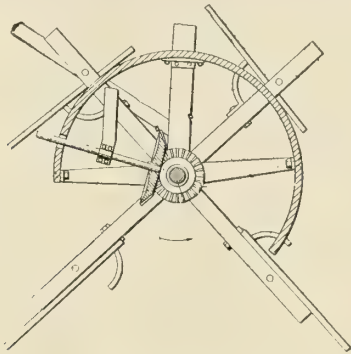
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

949,887. PADDLE-WHEEL. HENRY DUSEK, OF CAMERON, TEX.

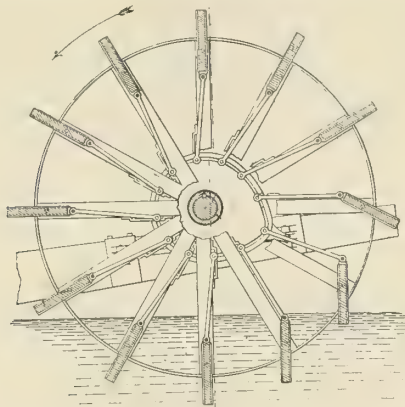
Claim 1—In a propeller the combination with a rotatable shaft; of a frame having one side portion keyed to said shaft, and the opposite side portion extending to a point adjacent said shaft, a blade pivoted be-



tween the sides of said frame, and a deflector arranged beneath the short side of said frame and in the path of movement of said blade. Five claims.

950,981. PROPELLER-WHEEL. CHARLES T. WOODBURN, OF MUNHALL, PA.

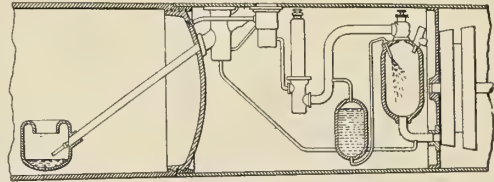
Claim 1—In a propeller wheel, the combination with supporting beams, an axle journaled in bearings on said supporting beams, hubs carried by said axle, and a plurality of spokes carried by said hubs, of transverse blades trunnioned between said spokes, links pivotally connected at one end to said blades, wrist pins carried by said links at the free ends thereof, cams loosely mounted upon said hubs and having cam grooves formed therein to receive said wrist pins, a disk mounted sta-



tionary upon each hub, a clutch disk loosely supported by each hub, latch levers pivotally connected to the clutch disks, brackets carried by said supporting beams, latches pivotally mounted in said brackets and having the outer ends of said latch levers pivotally connected thereto, projecting arms carried by said cams to engage with said brackets, and means interposed between said cams and said clutch disks for frictionally engaging the latter with the stationary disks. Two claims.

950,550. AIR HEATER FOR AUTOMOBILE TORPEDOES. FRANK M. LEAVITT, OF NEW YORK, N. Y., ASSIGNOR TO E. W. BLISS COMPANY, OF BROOKLYN, N. Y., A CORPORATION OF WEST VIRGINIA.

Claim 1—In an automobile torpedo, a compressed air reservoir, an engine, an intervening reducing valve, and means beyond said valve for heating the air under reduced pressure in its passage from the reservoir

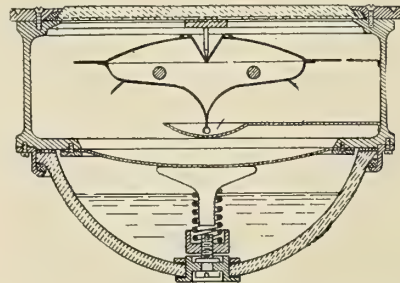


to the engine, combined with means for heating the air in the reservoir during the latter portion of the run whereby to expel a greater portion of the residual air. Seven claims.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton building, W. C., London.

19,057. MAGNETIC COMPASSES. KELVIN AND JAMES WHITE, LIMITED, OF GLASGOW. L. W. P. CHETWYND, MILL HILL, AND F. W. CLARK, GLASGOW.

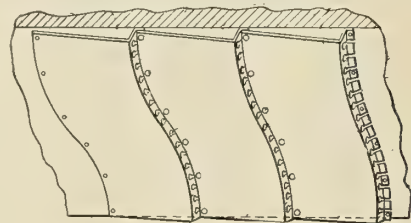
This invention relates to "liquid" compasses, in which the card is formed so that it shall resist any tendency to rock. The novel feature of the invention consists in forming that part which sustains the card of a section approximating to that of the mid-ship section of a ship. The under half of the float is thus built to give a steady platform, the curvature of the under half being partly concave and partly convex. To afford the maximum resistance to any tendency to rock the card out



of its plane, a ring is fitted around the under half of the float, to serve the purpose of a bilge keel, and to prevent the card from being thrown off its pivot, a cup-like device is provided serving as a guard which co-operates with a ball or weight at the under extremity of the card, and which is supported by means of a spring arm projecting from the side of the compass bowl. The needles may be wholly enclosed within the float, so that they are sheltered against the drag of the liquid when the vessel turns rapidly.

2,776. MEANS FOR THE REDUCTION OF WATER FRICTION ON THE SUBMERGED SURFACE OF SHIPS AND OTHER VESSELS. T. O. SMITH, SOUTHAMPTON.

According to this invention, vessels of ordinary construction are supplied with a sheathing such that their external surface may be of a form for reducing the water friction, the sheathing consisting of plates at one edge bent inwardly approximately at right angles to form a shoulder or



step, and then longitudinally to form a flange, the step being perforated with holes, and the flange provided with slots. The plates are applied so that the plain edge of one plate overlaps the flange of the shoulder or step of the next plate toward the bow and is fastened through the flange to the skin of the vessel.

7,837. MARINERS' COMPASSES. M. MUCH, DRESDEN, SAXONY.

In this device an electric circuit connects secondary compasses with a main compass and is closed and interrupted through the influence of light rays on selenium cells arranged in the circuit, the deflection of the magnetic needle causing a successive illumination of the cells. As the needle is constant in one direction, the position of the light chamber, relative to the cylinder connected to the needle, will alter with the course of the ship. At every 5 degrees the selenium cells will, in rotation, be exposed to the light of the objectives. The electrical resistance of selenium being weakened by light, the relays will respond to the light contact and switch on the electromagnets by means of the contacts. Every light contact of the main compass therefore results in a corresponding magnetic contact in the secondary compass and causes the needle of the latter to move 5 degrees in the same direction as the needle of the main compass.